간호학 석사학위논문

Lifestyle patterns, dietary intakes and body compositions of Korean female nursing students and their relations to bone mineral density

2014년 2월

서울대학교 대학원

간호학과 간호학 전공

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Lifestyle patterns, dietary intakes and body compositions of Korean female nursing students and their relations to bone mineral density

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이 논문을 간호학석사 학위논문으로 제출함
2013년 10월

서울대학교 대학원
간호학과 간호학 전공
박 다 인

박다인의 간호학석사 학위논문을 인준함
2013년 12월

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Abstract

Osteoporosis is one of the leading global health problems with no definitive cure available. It is usually diagnosed when one has fracture due to dramatically decreased bone mineral density (BMD). Peak bone mass (PBM) is established during one's late-20s. Once PBM is reached, the BMD slowly deteriorates over lifetime period. Therefore, an effort to maximize PBM should be established for osteoporosis prevention. It has been reported that lifestyle patterns, dietary intakes and body compositions have effects on BMD formation. Therefore, this study aims to describe Korean female nursing students' current BMD, lifestyle patterns, dietary intakes, body compositions and their relations to BMD.

A total of 160 female students attending to a nursing school at a college in Seoul, Korea were evaluated. Data collection took place from June 10th to October 25th of 2013. An ultrasonometer was used to determine BMD, one-on-one interview, survey, 24-hour recall and food diary methods were used to determine general characteristics, past and current lifestyle patterns and dietary intakes. An InBody 720 machine was used to analyze body compositions. Data were analyzed using Windows SPSS 20.0 program.

The results are as of the followings:

The average BMD (*t*-score) of the students was 0.37 (±1.26), and among these students 128 (80%) was in the normal range and 32 (20%) were in the below the normal range.

Currently, 59 students (36.9%) were involved in regular exercise, and they

spend about 1.25 (±1.58) times per week on exercising and spent 11.6 (±9.17) hours per week on outdoor activities. When students were divided into a high frequency group (>5h/wk) and a low frequency group (≤5h/wk) according to their past and current exercise hours, the number of students in the high frequency group were as of the followings: elementary school (71, 44.4%), middle school (43, 26.9%), high school (22, 13.8%) and current (24, 15%).

Students were divided into 3 groups according to the analysis of their food diaries: adequate, deficient and excessive. A total of 137 (85.6%) students had excessive sodium intakes and 86 (53.8%) had excessive cholesterol intakes. However, 109 (68.1%) had adequate fiber intake and 81 (50.6%) had adequate vitamin C intakes. Vitamin D deficiency was noted in 104 (65%) students, and calcium deficiency was noted in 84 (52.5%) students.

As for the body composition, the average BMI of the students, an indicative of their nutritional status, was 21.3kg/m^2 (±1.97). The students were divided into 3 groups according to their BMIs: normal (115, 71.8%), underweight (11, 6.9%) and overweight (34, 21.3%).

When the students were divided into 'normal BMD' and 'below the normal BMD' groups, variables that showed significant findings are as of the followings. Among lifestyle patterns, weekly exercise frequency (p=.05) and daily caffeine consumption (p=.07) showed significant differences between the groups. Also, weekly exercise hours during elementary school (p=.07), milk consumption during high school (p=.05) and current days (p=.02), and current breakfast consumption (p=.07) showed significant BMD differences. Only vitamin B5 (p=.07) and copper (p=.03) were significant among nutrients analyzed from the dietary intakes. As for the body compositions, BMI (p=.06)

and height (p=.03) showed significant differences.

This study showed that despite the fact that exercise frequency and caffeine consumption have effects on BMD, a large number of Korean female nursing students were not engaged in regular exercise and were consuming about 2 cups of caffeine daily. Although past and current milk intakes have a positive effect on BMD, our subjects showed a decreasing trend in milk consumption as they progressed from childhood into the adulthood. More than half of the subjects had excessive intakes of sodium and cholesterol that are known to have negative effects on general health. Also, more than half of the subjects had deficiency in vitamin D and calcium intakes.

Therefore, in order to strengthen Korean female college students' BMD, there is a need for comprehensive interventional programs that reinforces regular exercise, reduces caffeine, sodium and cholesterol intakes, and increases milk, breakfast, vitamin D and calcium intakes.

Key word: female college students, bone mineral density, lifestyle, dietary intake, body compositions

Student ID: 2012-20426

Contents

1. Introduction

Osteoporosis is one of the leading global health problems expected to affect more people at various age ranges (Ford, Bass, Zhao, Bai, & Zhao, 2011; Holroyd, Harvey, Dennison, & Cooper, 2012; "International Osteoporosis Foundation," 2013; Kohri et al., 2012; Rivas et al., 2012). It results in a subsequent increase in bone fragility and a susceptibility to fractures (Ford, Bass, Zhao, Bai, & Zhao, 2011). Due to an absence of a definitive cure, prevention is a key component in reducing the complications of low bone mineral density (BMD). Bone mass accumulation is steadily achieved until age 20-30 when the maximal peak bone mass (PBM) is acquired, which is the amount of bony tissue present at the end of the skeletal maturation (Bonjour, Theintz, Law, Slosman, & Rizzoli, 1994; D. S. Cho & Lee, 2008; Pampaloni et al., 2013).

Although until recent years, postmenopausal women were thought to be the most vulnerable population, there has been a tendency of an increase in osteoporosis diagnosis in women in their 20s-30s in Korea ("Health Insurance Review & Assessment Service," 2012). However, most of the previous research studies on osteoporosis and BMD have focused on perimenopausal, postmenopausal or elderly women. The very few previous studies on BMD in young adult women only focused on some of the modifiable factors or only focused on athletic women and, thus, lacked to provide the level of BMD and BMD modifying factors for average, non-athletic female college students (D. S. Cho, & Lee, J. Y, 2008; J. H. K. Cho, Soon Kyung, 2008).

Although about 50-70% of the variance in BMD within a population is determined by genetic factors, other manageable environmental determinants such as lifestyle patterns, dietary intakes, nutritional status and body compositions influence bone mass maturation (D. S. Cho & Lee, 2008; Marwaha et al., 2011; Nieves et al., 2010; Weaver, 2008).

Previous studies reported that exercise has a positive influence on bone health in various age groups (Allison, Folland, Rennie, Summers, & Brooke-Wavell, 2013; Balsamo et al., 2013; Marwaha et al., 2011). These studies suggest that an involvement in regular exercise contributes a significant BMD gain. Moreover, they have shown that a constant and frequent involvement in moderate intensity exercise is beneficial in bone formation. Unfortunately, however, the number of Korean adult females who are engaged in walking, moderate and heavy exercises have decreased dramatically within the last 6 year period (*2011 5th National Health & Nutrition Survey*, 2011). On the other hand, caffeine consumption has been reported to have a negative influence on BMD determination (Harter et al., 2013; Krall & Dawson-Hughes, 1993; Wetmore, Ichikawa, LaCroix, Ott, & Scholes, 2008). Studies have shown that not only current but also observations of past lifestyle patterns allow the rate of change of BMDs and the prevalence and cumulative incidence of osteoporotic fractures (Dennison, Yoshimura, Hashimoto, & Cooper, 1998; Ishimoto et al., 2013; Yoshimura et al., 1998). But most of the previous BMD studies conducted on Korean female college students have only assessed current health behaviors and lifestyle patterns.

Moreover, among dietary components and nutrients that are associated

with bone growth, calcium has been identified as one of the leading factors that decide overall BMD (Bolton-Smith et al., 2007; S. A. Shin, Hong, Choi, Roh, & Joung, 2008; Weaver, 2008). Still, the 2010-2012 Korea National Health and Nutrition Survey indicated calcium as the most deficient nutrient in Korean adults over the age of 19 years, especially in women. Besides calcium, some of the other nutrients such as protein, fat and several kinds of vitamins may also have positive effects on BMD, but the results are controversial (J. H. Cho & Kim, 2008; S. Shin & Joung, 2013).

Previous studies have also shown that nutritional status and body compositions are closely linked to bone formation and BMD in various populations (Castillo & de la Rosa, 2009; Felson, Zhang, Hannan, & Anderson, 1993; C. Kim & E. Kim, 2010; Murillo-Uribe et al., 1998). Heavier body compositions exert positive effects on BMD through weight bearing effects on bone structure (Lanyon, 1992; Lim, Bae, Lee, & Ahn, 2008; Salamat, Salamat, Abedi, & Janghorbani, 2013). Specific body compositions such as skeletal muscle mass, body fat mass, percent body fat and their relations to BMD are still being debated (Gnudi, Sitta, & Fiumi, 2007; Lee, 2013b; H. Shin, Liu, Panton, & Ilich, 2013). Studies have shown that majority of Korean female college students tend to have unfavorable body compositions such as low BMI, low skeletal muscle mass and high body fat mass and percent body fat due to extreme weight loss from unhealthy dieting and lack of exercise, and are, therefore, exposed to nutritional imbalance that affects BMD (D. S. Cho, & Lee, J. Y, 2008; Hong, Pak, & Sohn, 2012).

Therefore, this study aimed, first, to investigate past and current

lifestyle patterns, dietary intakes, and nutritional status and body compositions of Korean female college students. Second, it aims to analyze the relationship between these modifiable contributing factors and BMD. The study results are expected to explore and establish a comprehensive understanding of BMD modifiable factors and to provide more in-depth understanding of reasons for steadily increasing number of Korean young adult women with low BMD.

1. Research purpose

The aim of this study was to investigate the modifiable contributing factors of BMD formation including past and current lifestyle patterns, dietary intakes, nutritional status and body compositions, and their relationship to BMD in Korean female college students. The specific purposes were as of the followings:

1) To investigate past and current lifestyle patterns of female college students
2) To investigate dietary intakes of female college students
3) To investigate nutritional status and body compositions of female college students
4) To analyze relationship between past and current lifestyle patterns of female college students and their BMD
5) To analyze relationship between dietary intakes of female college students and their BMD
6) To analyze relationship between nutritional status and body composition of female college students and their BMD

2. Terminology

1) Bone mineral density (BMD)

Bone mineral density is a heritable complex trait used as an important predictor of fracture risk, and indicator of bone strength and a clinical diagnostic measurement of osteoporosis (Hoy, Macdonald, & McKay, 2013; Rivadeneira et al., 2009; Yoon et al., 2012). BMD is expressed as *t*-score, which is a World Health Organization (WHO) recommended measure that indicates the amount of one's BMD deviating from healthy young adults' reference mean (Doshi, Khan, Williams, & Licata, 2013; Matkovic, 1992; Roig-Vilaseca, Nolla, & Roig-Escofet, 2000).Calculation of *t*-score was based on the following equation:

$$t - score = \frac{(\text{subject}'\text{sBMD} - \text{young adult BMD})}{(\text{Standard deviation of young adult BMD})}$$

2) Past and current lifestyle patterns

Lifestyle patterns are defined as a way of living of individuals which manifest in coping with their physical, psychological, social, and economic environments on a day-to-day basis (O'Halloran et al., 2001). In this study, lifestyle patterns included behaviors that are known to be associated with BMD. To assess periodical lifestyle patterns and their relations to BMD, past and current behaviors were measured using Lifestyle Factor Questionnaire (LFQ) that was used in Wakayama Medical University's study (Ishimoto et al., 2013). Past lifestyle patterns refer to subjects' bone health related behaviors during elementary, middle and high school years, and current refers to those of present days'.

3) Regular exercise

Subjects' involvement in regular exercise was defined as an involvement in exercise for 3 days a week of moderate intensity (Kelley, Kelley, & Kohrt, 2013a, 2013b; Liang et al., 2011). Regular exercise did not include daily activities and only included activities that involved physical movements to sustain or improve health and fitness (Evans, Racette, Van Pelt, Peterson, & Villareal, 2007)

4) Caffeine consumption

Caffeine consumption was defined as consumption of beverages that contain caffeine chemical compounds, including coffee, tea, soda and energy drinks (Al-Othman et al., 2012; C. Kim & E. Kim, 2010).

5) Dietary intakes

Dietary intakes are defined as the consumption of nutrients via food items, and this information was obtained from a 24-hour recall method and analyzed by using Can-Pro 3.0 (J. H. Cho & Kim, 2008).

6) Nutritional status

Nutritional status was determined by body mass index (BMI, kg/m^2), of the subjects (Ahn, 2005; D. S. Cho, & Lee, J. Y, 2008; Yoshimura et al., 1998). According to the BMI results, subjects were categorized into three categories: underweight, normal and overweight (*2011 National Health Survey*, 2012).

7) Body compositions

Body compositions refer to the relative proportion of protein, fat, and mineral components in the body (Lee, 2013b; "Mosby's medical dictionary," 2009) For this study, body compositions referred to anthropometric measurements determined by height, weight, skeletal muscle mass, body fat mass, percent body fat, waist-hip ratio, visceral fat area measured by a body composition analysis machine (InBody 720, Biospace body composition analyzer, Newcastle, NE, USA).

II. Literature Review

1. The importance of bone mineral density in young females

According to the Health Insurance Review & Assessment Service data, the number of osteoporosis patients in Korea increased from 535,000 in 2007 to 773,000 in 2011. For this five year period, there was a 44.3% increase in osteoporosis incidence rate with annual average increase of 9.7% and an 18.7 billion won increase in the total osteoporosis-related medical expenses, an increase from 53.5 billion in 2007 to 72.2 billion in 2011. When the number of patients treated for osteoporosis was analyzed according to sex, the male share was only 6.4~7.5% compared to the female share of 92.5~93.6%, indicating female vulnerability and susceptibility to osteoporosis.

Osteoporosis is known to be more prevalent in menopausal women in their 50s (K. H. Kim et al., 2012; Schoffl et al., 2008; Tatsuno et al., 2013). However, recent studies have shown an increased prevalence and incidence rates of osteopenia and osteoporosis in young adult women population (M. Kim & Lee, 2010; Lim et al., 2008). The annual number of socially active women in their 20s~30s affected by osteoporosis is about 10,000, and a 4.6% increase was shown in 20~29-year-old women within a 5 year period ("Health Insurance Review & Assessment Service," 2012).

The amount of bone tissue in the skeleton, known as bone mass, can keep growing until around late 20s to age 30 when the maximum strength and density of bones, known as PBM, is reached ("Osteoporosis: Peak bone mass in women," 2009). Previous studies have shown that women tend to experience minimal changes in total bone mass from age 30 to menopause, but

then experience a rapid bone loss in the first few years after menopause largely due to hormonal changes (J. H. Cho & Kim, 2008; Lim et al., 2008). This rapid loss of BMD can lead to fragile bone and osteoporosis development, and put them at a high risk for osteoporotic fractures (Song, Paik, & Joung, 2008). It has been reported that the bone health is determined by the level of bone density when the PBM is reached which acts as a presumptive factor indicating the rate and the degree of bone loss in the future (Bonjour, Chevalley, Ferrari, & Rizzoli, 2009; J. H. Cho & Kim, 2008; "Peak bone mass and bone loss in postmenopausal osteoporosis," 1991). The denser the PBM is, the lesser the likelihood is for a person to develop osteoporosis in late adulthood (J. H. Cho & Kim, 2008; Deere, Sayers, Rittweger, & Tobias, 2012). Therefore, establishing relatively high PBM during early adulthood, especially in female population, may be the best and the most important preventative solution in bone health promotion and osteoporosis prevention.

2. Lifestyle patterns, dietary intakes, nutritional status and body compositions that influence the BMD of female college students

Regular exercise has been reported to have an important role in increasing bone mass in a large quantity of previous studies in various age groups. An involvement in regular and moderate level exercise in perimenopausal women has been reported to have positive effects in both bone mass enhancement and maintenance (Schoffl et al., 2008). Also, it has been reported to help maximize the PBM in adolescent population (Deere et al.,

2012). Caffeine intake has been cited as a risk factor for osteoporosis, and it has been associated with inhibition of intestinal calcium absorption and increased urinary calcium excretion (Rizzoli, 2008). However, the mechanism underlying this association is incompletely understood, and the majority of reported studies of this association have been conducted among postmenopausal women (Al-Othman et al., 2012; Conlisk & Galuska, 2000; Wetmore et al., 2008). Even though young adult women may be an important group since they are in the process of attaining PBM, only few studies have examined this association among this group. Female college students are at the age group that has been reported to take the biggest portion of caffeine consumers in Korea (Park & Oh, 2013). Not only current lifestyle patterns mentioned above but also past lifestyle factors are linked to bone formation during early adulthood, and ultimately affect the risk of osteoporosis development in later life (Ishimoto et al., 2013).

According to the 2011 National Health & Nutrition Survey, daily calcium intake was only 72.9% of the recommended daily requirement and was identified as the most deficient nutrient. Except for the infants (1~5yo), all age groups showed calcium intake of less than 80% of the recommended daily requirement (*2011 5th National Health & Nutrition Survey*, 2011). These data suggest calcium, a nutrient that has been reported to have a direct effect on bone mass maintenance and BMD enhancement, as the nutrient most susceptible to deficiency. The fraction of calcium deficient subjects in women (70.7%) were twice larger than that of men's (*2011 5th National Health & Nutrition Survey*, 2011). If calcium intake is inadequate during bone mass

accumulation period, it may lead to a low BMD, which in turn, may cause osteoporosis in the late adulthood (Lim et al., 2008). Many previous studies have also shown low intake values in other dietary intakes such as total calorie, protein and vitamin D in Korean female college students (D. S. Cho & Lee, 2008; J. H. Cho & Kim, 2008; Lim et al., 2008). However, their relationships with BMD are still inconclusive and controversial.

Nutritional status and body compositions have been linked to BMD (D. S. Cho, & Lee, J. Y, 2008; Fosbol, Dupont, Alslev, & Zerahn, 2013; Saravi & Sayegh, 2013). BMI, one of the measurements that indicate nutritional status, has been reported to have a positive effect on BMD (C. Kim & E. Kim, 2010). Body compositions are reported to have effects on BMD, but the specific components and their associations with BMD are controversial (C. Kim & E. Kim, 2010; Lu et al., 2011). Due to frequently skipping meals, eating out and establishing irregular meal times, college students are at risk for nutritional imbalance (Lim et al., 2008). For female college students, their chance of nutritional imbalance further increases due to biased aesthetic criterion (Miyabara et al., 2007). Among Korean female college students, it has been reported that there is a high social tendency of skinny physique preference, which causes self-starvation and frequent, extreme, improper diet practices that leads to severe weight loss and nutritional imbalances (Hong et al., 2012). Such behaviors have effects on one's nutritional status and body compositions, and may cause a negative influence on BMD.

III. Method

1. Design

This study was a cross-sectional, descriptive correlational study conducted on Korean female college students to investigate their past and current lifestyle patterns, dietary intake, nutritional status and body composition and to analyze the relationships between these factors and their BMD.

2. Subject

All female students enrolled in Seoul National University's (SNU) College of Nursing program in the year of 2013 were recruited into the study. The inclusion and exclusion criteria were as of the following:

1) Inclusion criteria

(1) Female college student in aging between 19~29

(2) Able to comprehend survey questions and answer accordingly

(3) Able to comprehend the purpose of the study and are able to give consent autonomously.

2) Exclusion criteria

(1) Currently has or has a history of bone disorder

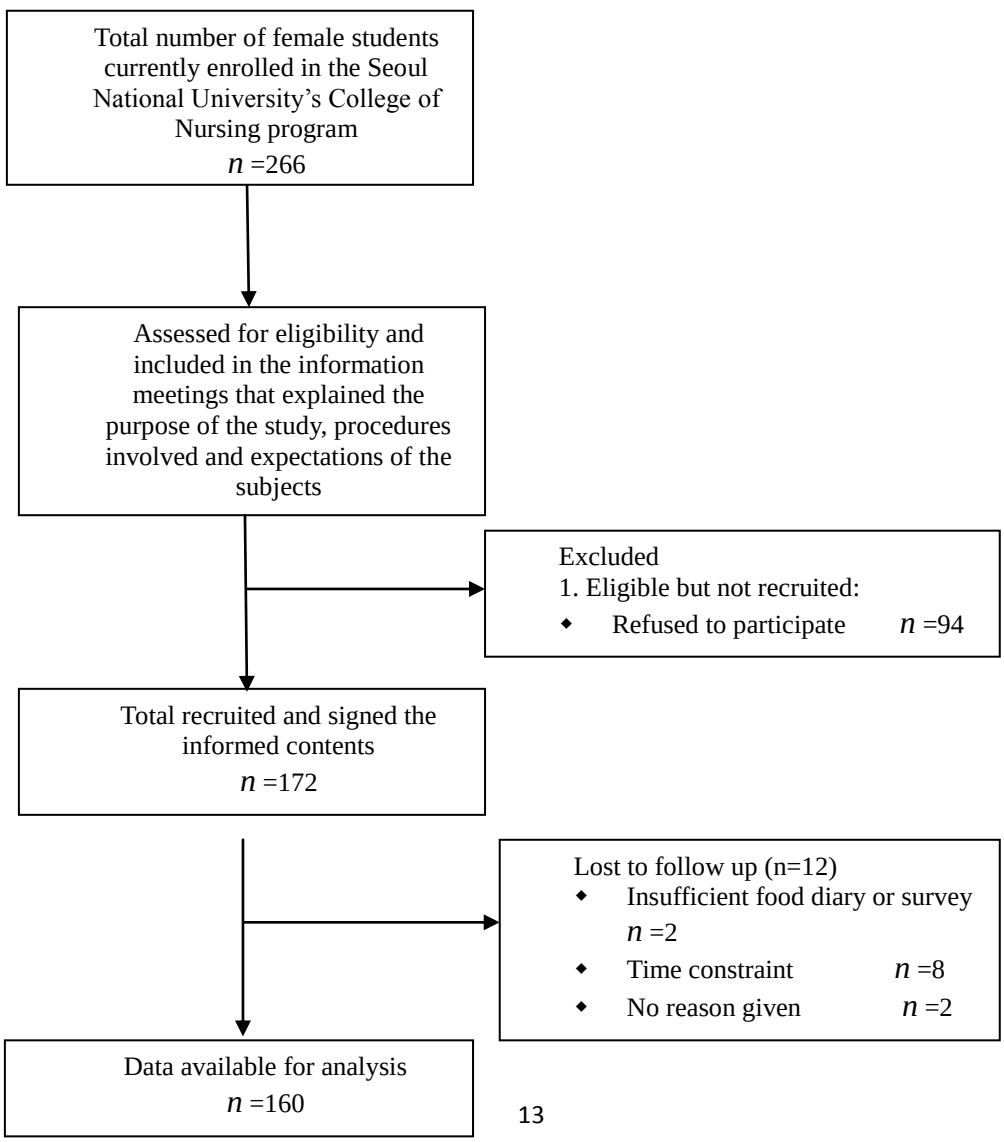
(2) Has parathyroid or thyroid disorder

(3) Has a surgical history that can directly impact on calcium metabolism such as esophagectomy or thyroidectomy.

(4) On a specific diet due to medication or medical regimen.

3) Sample

A total of 266 (93.3%) students were identified as females students currently enrolled in the SNU College of Nursing program. Initially, 172 (64.7% of the female nursing student population) students have agreed to participate in this study. However, among the initial participants, 12 (7.0 % of initial participants) students dropped out during the course of the study. Therefore, a total of 160 (60.9% of the female nursing student population) female students were selected as the final participants.



4) Sample size

Three different statistical test methods from G*Power 3.1.3 (G*Power, Faul & Erdfelder, Bonn, Germany) was used in order to determine the sample size of the study. First, in order to compare various variables' mean differences between a group of students with normal BMD and a group of students with at-risk BMD, *t*-tests with mean difference between two independent means (two groups) were selected as the test family and statistical test method with the following input parameters: two-tails, effect size (d) of 0.5, αerror probability of 0.05, power (1-βerror probability) of 0.80 and allocation ratio N2/N1 of 1. As a result, the program recommended the study to have a total sample size of 128. With a prediction of 10% dropout rate, the recommended study sample size was to at least be 141 subjects. Second, in order to compare mean *t*-scores related to past and current lifestyle frequencies, four different lifetime periods (elementary school, middle school, high school and current) were compared using ANOVA: fixed effects, omnibus, one-way statistical test with following the input parameters: effect size (f) of 0.4, αerror probability of 0.05, power (1-βerror probability) of 0.80 and number of groups of 4. As a result, the program recommended the study to have a total sample size of 76. With a prediction of 10% dropout rate, the recommended study sample size was to at least be 84 subjects. Last, in order to look at correlation between nutritional status and body compositions with BMD, correlation: bivariate normal model was selected with the following input parameters: two-tails, correlation p H1 of 0.3, αerror probability of 0.05, power (1-βerror probability) of 0.80 and correlation p H0 of 0. The recommended total sample size was 84,

and with 10% predicted dropout rate, at least 92 subjects were recommended for this study. With an actual dropout rate of 6.78% (*n*=12), the total number of subjects for this study was 160, fulfilling all three recommended sample sizes.

3. Measurement

1) General characteristics

Information on age, grade, menarcheal age, monthly allowance, residence, cohabitant(s), smoking habits, alcohol consumption, caffeine consumption, diet practice, regular exercise practice and use of sunscreen were measured by structured surveys. Medical histories, family history of osteoporosis, family members with osteoporosis, history of fracture and age at fracture were also measured by structured surveys.

2) Bone mineral density

A quantitative ultrasound (QUS) was used as the bone mass measuring method. QUS is a radiation-free, inexpensive, convenient and effective tool that provides information on bone microarchitecture assessing the overall bone strength and fracture risk (Alwis et al., 2010; Goh, Aragon, Lee, & Loke, 2011). The accumulation of bone mass measured at the calcaneus with QUS has been reported valid in reflecting one's overall BMD (Kohri et al., 2012; Matkovic, 1992). Therefore, in this study, BMDs of the subjects were measured using ultrasonic method (Achilles Express Ultrasonometer, GE Lunar Healthcare Corporation, USA) on subject's calcaneus. Calcaneus BMD

measurement using Achilles Express Ultrasonometer has been proven to have a diagnostic sensitivity comparable to dual-energy X-ray absorptiometry (DEXA) measurement of the spine and hip (Hans & Krieg, 2008; Krieg et al., 2008). This machine is the only QUS device cleared for monitoring bone changes by the Food and Drug Administration of United States(Gonnelli et al., 2002; Gonnelli et al., 1996). Calculated BMD measurements were expressed as *t*-scores. According to the *t*-score of subjects, they were, first, categorized as osteoporosis (*t* -score $\leq$ -2.5), osteopenia (-2.5 < *t* -score $\leq$ -1) or normal (*t* -score > -1) determined by the WHO's definitions (D. S. Cho, & Lee, J. Y, 2008). However, due to a small number of students with osteopeoporotic and osteopenic *t*-scores, subjects were recategorized into 2 groups for statistical purposes: 'normal BMD' (*t* -score > -1) and 'below normal BMD' (*t* -score $\leq$ -1).

3) Regular exercise

Regular exercise was defined as 3 days a week of moderate intensity exercise (Kelley et al., 2013a, 2013b; Liang et al., 2011). A 'yes,' or 'no' question was included in the survey to determine subjects' involvement in regular exercise. Subjects were also asked to write an estimated overall weekly frequency of exercise (day/week) and time spent (min/week) for outdoor activity. Using Wakayama Medical University's LFQ, past and current weekly exercise hours were also surveyed (Ishimoto et al., 2013). Using LFQ definitions, subjects were categorized into high- and low- frequency exercise groups according to their answers to past and current weekly exercise hours.

Those who exercise more than 5 hours/week were defined as high-frequency group, and those who had less than or equal to 5 hours/week were defined as low-frequency group (Ishimoto et al., 2013).

4) Caffeine consumption

Caffeinated beverage intake was self-reported by using a 'yes' or 'no' question included in the survey (Wetmore et al., 2008). Also, the frequency of daily caffeine intake was included.

5) Dietary intake

Subject's dietary intake was assessed with the use of the food diary and 24-hour recall method (Lim et al., 2008). The subjects kept record of their dietary intake for 3 days including 2 week days and 1 weekend to reflect their average weekly intake (Choi & Kim, 2008; Lim et al., 2008). The 3 day record was written on food diary format that was provided when they signed the consent form. A trained researcher reviewed the food diaries and conducted personal interviews to help the subjects to remember the amount of the food they had consumed by showing them food models and pictures and to specify the ingredients of each dish. All the food consumed for breakfast, lunch, dinner and snacks from rising in the morning till bedtime were surveyed. The types of food materials and the amount of food consumed were also be surveyed. Then, the daily nutrient intakes were analyzed by Computer aided nutrition analysis program (CAN-Pro 3.0; The Korean Nutrition Society, Seoul, Korea). Nutrients that were reported to have an influence on BMD, including those

that are still controversial, were analyzed (Bolton-Smith et al., 2007; Lee, 2013a; Weaver, 2008). Each nutrient examined was compared to the KDRIs, and those that are in <75% of their corresponding KDRIs was defined as a deficient intake ("Management of obesity, 2010 Recommendation," 2010). Also past and current breakfast intakes, milk intakes and other dairy product intakes (defined as dairy products other than milk, e.g. cheese, ice cream, yogurt, cream, yakult, etc.) from elementary school years up to college years, were surveyed using Ishimoto's LFQ (Ishimoto et al., 2013).

6) Nutritional status and body compositions

Subject's nutritional status (BMI) and body compositions (height, weight, body fat mass, skeletal muscle mass, percent body fat, waist-hip ratio and visceral fat area) were measured using InBody720 (Biospace, CA, U.S.A.). InBody 720 has been proven to have a great accuracy with high correlation coefficient of 0.98 with DEXA, the standard equipment for body composition analysis ("InBody720 for research grade analysis ", 2009). The machine uses direct segmental multi-frequency bioelectrical impedance analysis (DSM-BIA) method with 30 impedance measurements by using 6 different frequencies (1^{KHz}, 5^{KHz}, 50^{KHz}, 250^{KHz}, 500^{KHz}, 1000^{KHz}) at each 5 segments (right arm, left arm, trunk, right leg, left leg) ("InBody720 for research grade analysis ", 2009). Nutritional status was determined by BMI result, and the subjects were categorized as underweight (< 18.5), normal (18.5 – 22.9), or overweight (≥23) according to Korean Ministry of Health & Welfare guidelines (*2011 National Health Survey*, 2012). According to their results for percent body fat, waist-

hip ratio and visceral fat area, subjects were divided into categories defined by WHO. Percent body fat was divided into three categories: underfat (<21%), normal (21-33%) and overweight (>33%) (Gallagher et al., 2000). Waist-hip ratio was divided into two categories: normal (<0.85) and abdominal obesity (≥0.85) (Oh et al., 2005). Visceral fat are was divided into two categories: normal (<100cm^2) and increased visceral fat (≥100cm^2).

4. Data collection

This study was conducted for four months (from June to October of 2013) at SNU College of Nursing on female nursing students who fit the inclusion criteria mentioned above and signed the consent forms.

1) Ethical considerations

Prior to data collection, this study was reviewed and approved by Institutional Review Board (IRB) of SNU College of Nursing on June 7th, 2013 (approval number: 2013-37).

2) Study procedure

Study procedure was carried out from June 10th, 2013 to October 25th, 2013 at SNU College of Nursing by the researcher with previous related studies on older women. The study procedure is described in the following order: subject recruitment, subject screening, information meetings, measurements, and completed survey and 3 day food diary collections.

In order to protect human rights during the recruitment, four 30-

minute information sessions were held to explain the purpose of the study, procedures involved in the study, expectations of the subjects, inclusion and exclusion criteria and subjects' choice of voluntary participation and withdrawal from the study. Each information session was held in each grade level students' classrooms and visual PowerPoint presentations and written handouts were given. For those students who have agreed and signed the consent forms, a copy of the consent form was given and another verbal explanation of the purpose and the procedure of Inbody 720, BMD ultrasonometer and survey tools were provided. After the measurements, a verbal explanation of a comprehensive interpretation of Inbody and BMD results were given as well. BMD and Inbody measurements and 3day food diary recollection were carried out at subjects' convenient dates and times. Subjects were asked to write their reachable phone numbers on the surveys. However, prior to survey, subjects were informed about the purpose of collecting phone numbers, method of data keeping, and expected data disposal method. An excess password, which is known only to the researcher, has been created on the server where collected personal data are stored, and all the data are to be disposed upon the completion of the study.

Quality assurance test was performed prior to each BMD measurement, and subjects were measured only if the QUS has passed the quality assurance test. In order to keep consistency of BMD measurement site, all subjects' right calcaneus measurements were evaluated. To avoid any technical errors, each subject's BMD measurement was taken twice and an average of the two t-scores was used for analysis. Seventy percent isopropyl alcohol has been used

as the conductive agent. The GE QUS device used in this study uses fluid-coupled, through-transmission (95mm distance) with quarter wave-matched, broadband single element (25mm diameter) and center frequency of 500 ^{KHz}. A single analysis uses a real-time, fourier transform analysis with bi-directional measurement and convergence algorithms to display stiffness index with WHO graph and WHO-based t-score ("Achilles express: bone ultrasonometer ", 2011).

As for the dietary intakes, written guidelines, formats and sample food diaries were given to the subjects during the information sessions. Also, during these information sessions, plastic food models were shown to the subjects to educate about portion sizes. Subjects were asked to write food diaries in detail, including specific ingredients if possible. Moreover, in order to avoid any dietary fluctuations from subjects' normal patterns, data collection was conducted during the academic semesters to avoid different eating behaviors during subjects' summer break. To avoid fluctuations related to 'back-to-school' parties, data collection was postponed for 2 weeks after the start of fall semester. Also, holidays such as Choo-seok, a Korean thanksgiving day, were avoided to avoid nutritional fluctuations.

Due to DSM-BIA method that is incorporated in the use of InBody 720, subjects were, first, asked if they had any implantable electrical device such as pacemaker, defibrillator, nerve stimulator, or if they were within the first twelve weeks of pregnancy. For data accuracy, subjects were asked to be measured on an empty stomach and bladder, before exercise and to avoid being measured right after a shower or using a sauna as sweat and heat causes

a temporary change in conductivity within the body. Also, subjects were asked to remove their shoes, socks, jewelry and to wear light clothing. Height was measured using an automatic stadiometer (Model BSM370, Biospace height weight scale stadiometer analyzer, Newcastle, NE, USA) prior to the body composition analysis. Then height was inputted accurately into the InBody 720, to prevent any technical errors. During body composition analysis, subjects' were asked to hold handles with bioelectrical devices in each hand and to hold their arms away from the side of the body, not touching the body.

5. Data analysis

Statistical analysis of collected data was performed using SPSS software package (PASW Statistics version 20.0 for Windows, SPSS, Chicago, IL, USA).

1) General characteristics were analyzed using frequency distribution, fraction, mean and standard deviation.

2) Past and current lifestyle patterns were analyzed using frequency distribution and fraction.

3) Dietary intakes were analyzed using CAN-Pro 3.0, and subject's nutrient intake was compared to Korea's daily recommended amount to determine deficiency and excessiveness.

4) Nutritional status and body compositions were analyzed using frequency distribution, fraction, mean and standard deviation.

5) The general characteristics of the subjects, dietary intakes, and nutritional

status and body compositions of the subjects with different BMD status were compared using *t*-test.

6) The past and current lifestyle patterns of the subjects with different *t*-scores were compared using ANOVA.

IV. Results

1. Characteristics of the subjects

1) General characteristics of the subjects

The average age of the subjects was 20.6 (±1.48). The subjects included all grade levels, where sophomore group had the largest number of participants (*n*=50, 31.3%), followed by freshmen (*n*=41, 25.6%), juniors (*n*= 37, 23.1%) and seniors (*n*=32, 20%). In average, students started their menstrual cycle at the age of 12.4. More than half of the students received monthly allowance of more than 401,000 won (*n*=89, 55.6%) and lived in the school dormitory (*n*=85, 53.1%) with roommate(s) (*n*=95, 59.4%). Only 2 subjects (1.3%) identified themselves as current smokers, but 118 (73.8%) and 144 (90%) identified themselves as alcohol and caffeine consumers respectively. One hundred and one (63.1%) students denied of being on a diet, or participating in regular exercises. 123 (76.9%) students used sunscreen to protect their skin, and, on an average, they used sunscreen with SPF level of 32.7 for 4.5 days per week.

None of the subjects had any history of bone health related illnesses, and the majority had no history of medical conditions. However, 17 (10.6%) students had been diagnosed with medical conditions in the past such as atopic dermatitis (*n*=8, 47.1%), allergic rhinitis (*n*=5, 29.4%), polycystic ovary syndrome (*n*=2, 11.8%), hyperlipidemia (*n*=1, 5.85%) and asthma (*n*=1, 5.85%). Twenty five (15.6%) students had a family history of osteoporosis: 16 (64%) with grandmothers with osteoporosis and 9 (36%) with mothers with osteoporosis. Twenty eight (17.5%) students had histories of fracture with a

mean age of 11. Sixteen students (57.1%) experienced bone fracture when they were younger than the group average age 11, and 12 (42.9%) experienced when they were older than 11. Sixteen students fractured their upper extremities, 10 fractured their lower extremities, 1 fractured her hip bone, and 1 fractured her lumbar spine.

The mean *t*-score of all subjects was 0.37 (±1.26), which is within the normal range. However, 20% of the subjects (*n*=32) had *t*-scores that were below the normal range. Among these subjects, 30 (18.8%) were identified as osteopenic, and 2 (1.2%) were identified as osteoporotic. Further analysis have indicated that, among all four grade levels, the number of seniors was the highest within the 'below the normal range' group (*n*=10, 31.3%). (Table 1).

Table 1. General characteristics of the subjects (*N*=160)

Variables		**Mean (±SD)**	***n*(%)**
Age (years)		20.6±1.48	
Grade	Freshman		41 (25.6)
	Sophomore		50 (31.3)
	Junior		37 (23.1)
	Senior		32 (20)
Menarcheal age		12.4±1.14	
Monthly allowance (x10,000 won)	0-20		7 (4.4)
	20.1~40		64 (40)
	>40.1		89 (55.6)
Residence	Parent(s)' house		52 (32.5)
	Dormitory		85 (53.1)
	Own place		23 (14.4)
Cohabitant(s)	With parent(s)		52 (32.5)
	With roommate (s)		95 (59.4)
	Alone		13 (8.1)
Smoking	Yes		2 (1.3)
	No		158 (98.7)
Alcohol consumption	Yes		118 (73.8)
	No		42 (26.2)
Average amount of alcohol consumption per week (glasses)#		4.23 ± 1.32	
Caffeine consumption	Yes		144 (90)
	No		16 (10)
Frequency of caffeine intake/day#		1.69 (±0.95)	
Currently on a diet †	Yes		59 (36.9)
	No		101 (63.1)
Regular exercise	Yes		59 (36.9)
	No		101 (63.1)
Frequency of exercise/wk#		1.25 (±1.58)	
Outdoor activity hrs/wk#		11.6 (±9.17)	
Use of sunscreen	Yes		123 (76.9)

	No		37 (23.1)
Used sunscreen SPF level		32.7 (±16.1)	
Frequency of sunscreen usage/wk		4.53 (±2.71)	
Medical diagnosis	Yes		17 (10.6)
	No		143 (89.4)
Family history of osteoporosis	Yes		25 (15.6)
	No		135 (84.4)
Family member with osteoporosis	Grandmother		16 (64)
	Mother		9 (36)
History of first fracture	Yes		28 (17.5)
	No		132 (82.5)
Age at fracture ††	≤11		16 (57.1)
	>11		12 (42.9)
BMD (*t*-score) †††		0.37(±1.26)	
	Normal		128 (80)
	Osteopenia		30 (18.7)
	Osteoporosis		2 (1.3)

Mean value of the number of subjects who answered 'yes' to the previous variable
† Diet refers to an act of intentional selection or limitation on the amount or type of food intake for reducing weight. Subjects were asked to answer the purpose of their diets in order to exclude those who are on a diet designed or prescribed to improve their physical condition or to prevent or treat a disease. However, all of the 59 students currently on a diet regimen were excluded from this criterion. They were all on a diet for the purpose of achieving slimmer physique.
†† By using the average age of subjects who have experienced fracture (age 11), subjects were divided into two groups.
††† Bone mineral density
*p<.05, **p<.01

2) Past and current lifestyle patterns of the subjects

For analysis of past and current lifestyle habits associated with bone health, subjects were divided into groups based on frequency: high and low. According to LFQ, high frequency was defined for each parameter as the followings: having breakfast (including everyday and 2-3 times/wk), milk intake every day, other dairy product intake every day, and exercise >5 hr in a week (Ishimoto et al., 2013). One hundred and fifty one students (94.4%) consumed breakfast during elementary school, 146 (91.3%) in middle school, 148 (92.5%) in high school and 109 (68.1%) in current days. As for the high frequency milk intake group, 129 (80.6%) in elementary school, 88 (55%) in middle school, 62 (38.8%) in high school and 38 (23.8%) in current days were identified. As for the high frequency other dairy product intake group, 71 (44.4%), 52 (32.5%), 45 (28.1%) and 38 (23.8%) were identified respectively. Last, for the high frequency weekly exercise hour group, 71 (44.4%), 43 (26.9%), 22 (13.8%) and 24 (15%) were identified respectively (Table 2).

Table 2. Past and current lifestyle patterns of the subjects (*N*=160)

Variables			***n*(%)**
Breakfast intake	Elementary school	Consuming	151 (94.4)
		Skipping	9 (5.6)
	Middle school	Consuming	146 (91.3)
		Skipping	14 (8.7)
	High school	Consuming	148 (92.5)
		Skipping	12 (7.5)
	Current	Consuming	109 (68.1)
		Skipping	51 (31.9)
Milk intake	Elementary school	Every day	129 (80.6)
		Less	31 (19.4)
	Middle school	Every day	88 (55)
		Less	72 (45)
	High school	Every day	62 (38.8)
		Less	98 (61.2)
	Current	Every day	38 (23.8)
		Less	122 (76.2)
Other dairy product intake	Elementary school	Every day	71 (44.4)
		Less	89 (55.6)
	Middle school	Every day	52 (32.5)
		Less	105 (67.5)
	High school	Every day	45 (28.1)
		Less	115 (71.9)
	Current	Every day	38 (23.8)
		Less	122 (76.2)
Weekly exercise hours	Elementary school	>5h/wk	71 (44.4)
		≤5h/wk	89 (55.6)
	Middle school	>5h/wk	43 (26.9)
		≤5h/wk	117 (73.1)
	High school	>5h/wk	22 (13.8)
		≤5h/wk	138 (86.2)
	Current	>5h/wk	24 (15)
		≤5h/wk	136 (75)

3) Dietary intakes of the subjects

According to the analysis of subjects' 3d food diaries via Can-Pro, some of the nutrients were notable in which more than half of the subjects had either deficient or excessive intakes. In this study, only those that are bone-health-related and health-behavior-related nutrients were focused in this study. The nutrients that had more than 50% of the subjects with deficiency were vitamin D, biotin, calcium, chlorine, potassium, magnesium and iodine. Those that had more than 50% of the subjects with excessive intakes were sodium, fluorine and cholesterol (Table 3).

Table 3. Dietary intakes of the subjects (*N*=160)

Variables		**Mean (±SD)**	***n* (%)**
Total energy (Kcal/day)†		1985.1 (±437.5)	
Carbohydrate (g/day)†		272.2 (±57.5)	
Fat (g/day)†		65.3 (±20.3)	
Protein (g/day)	Deficient (<75% KDRI)		1 (0.6)
	Adequate		159 (99.4)
Fiber (g/day)	Deficient		51(31.9)
	Adequate		109 (68.1)
Vitamin D (μg/day)	Deficient		104 (65.0)*
	Adequate		56 (35.0)
Vitamin K (μg/day)	Deficient		3 (1.9)
	Adequate		157 (98.1)
Vitamin C (mg/day)	Deficient		79 (49.4)
	Adequate		81 (50.6)*
Biotin (μg/day)	Deficient		130 (81.3)*
	Adequate		18.5 (18.8)
Calcium (mg/day)	Deficient		84 (52.5)*
	Adequate		76 (47.5)
Phosphorus (mg/day)	Deficient		1 (0.6)
	Adequate		159 (99.4)
Sodium (mg/day)	Adequate		23 (14.4)
	Excessive		137 (85.6)*
Chlorine (g/day)	Deficient		156 (97.5)*
	Adequate		4 (2.5)
Potassium (g/day)	Deficient		101 (63.1)*
	Adequate		59 (36.9)
Magnesium (mg/day)	Deficient		159 (99.4)*
	Adequate		1 (0.6)
Zinc (mg/day)	Deficient		11 (6.9)
	Adequate		149 (93.1)
Copper (μg/day)	Deficient		12 (7.5)
	Adequate		148 (92.5)
Fluorine (mg/day)	Deficient		12 (7.5)
	Adequate		23 (14.4)
	Excessive		125 (78.1)*
Manganese (mg/day)	Deficient		60 (37.5)

	Adequate	98 (61.3)
	Excessive	2 (1.3)
Iodine (μg/day)	Deficient	87 (54.4)*
	Adequate	73 (45.6)
Cholesterol (mg/day)	Adequate	74 (46.3)
	Excessive	86 (53.8)*

† Because recommended total energy, carbohydrate and fat intakes depend on the subject's body composition, and because the ratio rather than the amount of the intakes of these dietary components is more emphasized, the mean values (±standard deviation) were analyzed (*2011 5th National Health & Nutrition Survey*, 2011).

*$n \geq 50\%$ of total subjects

4) Nutritional status and body compositions of the subjects

Nutritional status based on BMI showed that 115 subjects (71.9%) were within the normal range, but 45 subjects (28.1%) deviated with 11 (6.9%) being underweight and 34 (21.3%) being overweight. The average weight and height of the subjects were 55.2 (±5.68) and 161 (±4.02) respectively. The average body fat mass and skeletal muscle mass were 16.9(±3.71) and 20.5(±1.77). The average percent body fat was 30.1(±4.18). Subjects were categorized into 3 groups according to their percent body fat with WHO definitions. One hundred and twelve students (70%) were within the normal range, but 4 (2.5%) were identified as having underfat and 44 (27.5%) were identified as overweight with too much percent body fat. Waist-hip ratio was categorized into normal (*n*=135, 84.4%) and abdominal obesity (*n*=25, 15.6%). Visceral fat area was also categorized into 2 groups: normal (*n*=157, 98.1%) and increased visceral fat (*n*=3, 1.9%) (Table 4).

Table 4. Nutritional status and body composition of the subjects (*N*=160)

Variables		**Mean (±SD)**	***n* (%)**
Nutritional status†		21.31(±1.97)	
	Normal		115 (71.8)
	Underweight		11 (6.9)
	Overweight		34 (21.3)
Weight (kg)		55.2(±5.68)	
Height (cm)		161.0(±4.02)	
Body fat mass (kg)		16.9(±3.71)	
Skeletal muscle mass (kg)		20.5(±1.77)	
Percent body fat (%)		30.1(±4.18)	
	Normal		112 (70)
	Underfat		4 (2.5)
	Overweight		44 (27.5)
Waist-hip ratio		0.81(±0.03)	
	Normal		135 (84.4)
	Abdominal obesity		25 (15.6)
Visceral fat area (cm^2)		38.6(±12.3)	
	Normal		157 (98.1)
	Increased visceral fat		3 (1.9)

† Defined by Body mass index (BMI) (kg/m^2)

2. Comparative and correlational statistics of observed variables with BMD

1) Comparison of general characteristics between subjects with different BMD groups

Among identified general characteristics, there was a mean difference in *t*-scores between the 'normal' and 'below normal' groups for daily frequency of caffeine intake (p=.07) and weekly frequency of exercise (p=.05) with a marginal significance (Table 5).

Table 5. General characteristics of the subjects with different *t*-score status (N=160)

Variables	**Mean(±SD)**	**Normal BMD: *t*-score >-1.0 (*n* =128, 80%)**	**Below normal BMD: *t*-score ≤ -1.0 (*n* =32, 20%)**	***p*†**
Frequency of caffeine intake/day	1.69(±0.95)	1.59 (±1.10)	2.05 (±1.82)	.07
Frequency of exercise/wk	1.25(±1.58)	1.37 (±1.98)	0.78 (±1.39)	.05

†Significance among groups was determined by *t*-test; *, p<0.05

2) Comparison of past and current lifestyle patterns between subjects with different BMD groups

Due to different distribution of 'normal' and 'below normal' students within high- and low- frequency groups for past and current lifestyle patterns, only *t*-score comparison between frequency groups were analyzed. Table 6 compares *t*-scores between high- and low-frequency groups for each parameter during elementary school, middle school, high school and the current days. *t*-score was significantly associated with current high milk intake frequency (vs. less than every day, p=0.02). Current breakfast intake (vs. skipping, p=.07), high milk intake frequency during high school (vs. less than every day, p=.05) and longer exercise duration during elementary (vs. less than 5hr/wk, p=.07) had a tendency of having associations with *t*-score (Table 6).

Table 6. Past and current lifestyle patterns of the subjects and their relation to *t*-score (*N*=160)

Variables			**Mean(±SD)**	***p*†**
Breakfast intake	Current	Consuming	.53(±1.66)	
		Skipping	.03(±1.41)	.07
Milk intake	High school	Every day	.68(±1.64)	
		Less	.17(±1.55)	.05
	Current	Every day	.89(±1.65)	
		Less	.20(±1.55)	.02
Weekly exercise hours	Elementary school	>5h/wk	.63(±1.52)	
		≤5h/wk	.16(±1.63)	.07

† Significance among groups was determined by *t*-test; *, p<0.05

3) Comparison of dietary intakes of the subjects with different BMD groups

Among analyzed nutrients, only copper had a significant difference between the normal BMD and below normal BMD groups. The students who had normal *t*-scores had a significantly higher intake of copper (p=0.03), and higher intake of vitamin B5 (p=0.07) with a marginal significance (Table 7).

Table 7. Dietary intakes of the subjects with different *t*-score status (N=160)

Variables	**Mean(±SD)**	**Normal BMD: *t*-score >-1.0 (*n* =128, 80%)**	**Below normal BMD: *t*-score ≤ -1.0 (*n* =32, 20%)**	***p*†**
Vitamin B5	4.06(±1.57)	4.19 (±1.90)	3.50 (±1.86)	0.07
Copper	1.09(±0.28)	1.12 (±0.37)	0.98 (±0.30)	0.03*

† Significance among groups was determined by *t*-test;
*, p<0.05

4) Comparison of nutritional status and body composition of the subjects with different BMD groups

There were significant differences in height (p=.03). We also found a mean difference in BMI (p=.06) with a marginal significance between the two groups. Subjects with normal t-scores were significantly shorter than those in with below normal t-scores (p=.03), and had a tendency to have higher BMI (p=.06) (Table 8).

Table 8. Nutritional status and body composition of the subjects with different *t*-score status (N=160)

Variables	**Mean(±SD)**	**Normal BMD: *t*-score >-1.0 (*n* =128, 80%)**	**Below normal BMD: *t*-score ≤ -1.0 (*n* =32, 20%)**	***p*†**
BMI (kg/m^2) ††	21.3(±1.97)	21.5 (±2.70)	20.5 (±2.02)	.06
Height (cm)	161.0(±4.02)	160.5 (4.73)	162.7 (±6.45)	.03*
Weight (kg)	55.3(±5.68	55.5 (±7.70)	54.5 (±6.88)	.51
Skeletal muscle mass (kg)	20.5(±1.77)	20.6 (±2.32)	20.4 (±2.32)	.65
Body fat mass (kg)	16.9(±3.71)	17.1 (±4.99)	16.2 (±4.35)	.33
Percent body fat (%)	30.2(±4.18)	30.3 (±5.23)`	29.6 (±5.57)	.50
Waist-hip ratio	0.81(±0.03)	0.81 (±0.04)	0.80 (±0.37)	.31
Visceral fat area (cm^2)	38.6(±12.3)	38.7 (±18.3)	38.1 (±14.8)	.86

† Significance among groups was determined by *t*-test; †† Body mass index; *, p<0.05

V. Discussion

Our study has investigated the lifestyle patterns, dietary intakes, nutritional status, and body compositions of female college students at a nursing school in Seoul, Korea and the effects of those parameters on BMD.

In this study of young Korean female college students, we found that out subjects had a high ratio of caffeine consuming students (90%) (Conlisk & Galuska, 2000; Wetmore, Ichikawa, LaCroix, Ott, & Scholes, 2008). Our study showed much higher than that of previous Japanese studies 23.1% and 67.6% respectively) (Furukawa et al., 2013; Shimamoto et al., 2013). However, our result was similar to that of previous Korean female college student studies including both general education majors and nursing majors, where close to or more than 80% of the subjects were caffeine consumers (Chon, Jeon, & Kim, 2012; J. Y. Kim, 2010). On an average, our subjects consumed about 2 cups (about 400ml) of caffeine on a daily basis, which is considered as a high consumption of caffeine according to previous studies (Hallstrom et al., 2013; J. Kim, 2010). Further analysis has found that the ratio of students who had high caffeine consumption was much higher in our students (41.9%) than previous studies on Western students (33.6%) and Korean students (29.7%) (Hallstrom et al., 2013; J. Kim, 2010). Congruent with previous studies, our study has also found that more frequent caffeine intake per day had a negative effect on *t*-score (Harter et al., 2013; Wetmore et al., 2008). Students with below the normal BMD consumed more than 2 cups of caffeine per day. Our hypothesis is that these results may have stemmed from an increased number of coffee shops in Korea within the last decade (J. Kim, 2010; Park & Oh, 2013).

We found that our results on the past and current lifestyle patterns related to breakfast was partly consistent with Korean national and previous study data ("Health Insurance Review & Assessment Service," 2012). Although our subjects consumed breakfast in the past, currently, 31.9% of our subjects identified themselves as breakfast skippers. This was similar to that of the national data, which has identified the age group 19-29 as the largest group that skips breakfast (*2011 5th National Health & Nutrition Survey*, 2011). Our data has shown a tendency of mean *t*-score difference between the current breakfast consuming students and breakfast skipping students (p=.07). However, the portion of our subjects who currently skip breakfast was more than three times larger than that of a previous Japanese study (11.5%) (Ishimoto et al., 2013). This discrepancy may be explained through the living places of the subjects. Most of our subjects lived away from their parents' house (67.5%), which put the subjects responsible for preparing for their own breakfast. Previous study that compared Korean and Japanese female colleges students' lifestyle patterns also showed that much larger portion of Korean students skipped breakfast compared to Japanese students, and that bigger number of Korean students were living apart from their parents compared to Japanese students who mostly lived at home (Kim & Sawano, 2010). Although our study did not include the reason behind breakfast skipping behavior, previous studies have identified that students tend to skip breakfast due to time constraint (Choi, Shin, Huh, & Chung, 2009; Chung et al., 2010; Kim & Sawano, 2010). Our hypothesis was supported by further analysis. Compared to freshmen and sophomores (28.1%), who mostly live at home and commute to school, larger percentage of juniors and seniors (36.6%), who are

recommended to live in the dormitory due to clinical practicum schedules, were identified as breakfast skippers.

Surprisingly, we found that a large portion of subjects had excessive intakes of sodium and cholesterol. The average sodium intake was about 3 times greater than the KDRI of 1.5g, and 85.6% of the subjects were identified to have excessive sodium intakes. Also, more than half of our subjects (53.8%) displayed excessive intake of cholesterol in their diet. Surprisingly, the subjects' sodium intake and cholesterol intake were much larger than that of previous Korean studies but similar to that of a western study (J. H. Choi & Kim, 2008; Lim et al., 2008; Larson et al., 2009). These results may be linked to the current Korean college students' westernized diets, which usually contain high amount of sodium and cholesterol. Our hypothesis was supported by further analysis of students' dietary intakes. When students consumed western foods such as pasta, pizza, burgers, sandwiches and friend foods, the sodium and cholesterol intakes increased compared to when they consumed traditional Korean foods. Also, the sodium and cholesterol's contribution ratio from these food items took up the majority of the daily sodium (63.1%) and cholesterol (72%) intakes of the subjects. Also, further analysis of 3 day food diaries have indicated that the majority of high-sodium and high-cholesterol food intakes tended to be from late-night snacks. Students, especially those who lived in the dormitory, tended to consume fast foods and delivery foods that contained excessive sodium and cholesterol, such as ramen noodles, fried chicken, Chinese foods and pizza for late-night snacks. Juniors and seniors (70.6%), who mostly live in the dormitory had higher portion of subjects with excessive cholesterol intake compared to freshmen and sophomores (56.1%)

Similar to previous studies, unhealthy dietary habits were identified in our subjects who were involved in dormitory life (Yaguchi-Tanaka, Kawagoshi, Sasaki, & Fukao, 2013).

Although a relatively large number of subjects were found to have excessive sodium and cholesterol intakes, reflecting an undesirable health behavior, a high ratio of our subject had adequate fiber and vitamin C intakes compared to previous studies on western and Korean students (Byrd-Williams, Strother, Kelly, & Huang, 2009; Cho, 2008; Kumar, Mittal, Orito, Ishitani, & Ohta, 2010). Further investigation of these dietary intakes has shown different ratio of students with adequate intakes according to the grade levels. The lower (freshmen and sophomores) classmen had significantly higher mean fiber intake (p=.01) and vitamin C intake (p<.01) than the upper classmen (juniors and senior). Although the fiber intakes in each grade was similar to another, a decreasing trend was noted in adequate vitamin C consumers as the grade level got higher (freshmen: 68.3%; sophomores: 60.4%; sophomores: 35.9%; seniors: 25%). Further statistical analysis has shown that freshmen's average vitamin C intake was significantly higher than juniors' (p<.01) and seniors' (p=.01), and sophomores' was significantly higher than juniors' (p=.05). These results may have been related to the residential area of the students, similar to a previous study (Nelson & Story, 2009). The amount of vitamin C intake decreased as the students lived apart from their family and head house, possibly indicating a general lack of fruit consumption when female college students became responsible for their own dietary intakes.

We found that, in relation to bone health, a relatively large portion of our subjects had deficiencies in calcium and vitamin D. Compared to female

college students abroad, our subjects' calcium intake was much lower, which was consistent with studies that reported low calcium intake in Korean females (Cho, 2008; C. Kim & Kim, 2010; Larson et al., 2009). This difference in intake levels may be closely related to the differences in food cultures and comparatively lower intake of milk and dairy products in Korean population than the western countries (C. Kim & E. Kim, 2010). Although our study was similar to that of previous studies on Korean female students in which more than half of the subjects were deficient in calcium, the average calcium intake was slightly higher in our subjects (Hong et al., 2012; Lim et al., 2008). However, the difference may have been from the study methods. The food frequency questionnaires in Hong's and a low number of subject in Lim's study (n=38) were indicated, therefore, our results may portray more accurate and provide better understanding of calcium intake among female college students. Further analysis of our data has noted that about half of each grade had calcium deficiency: 53.7% in freshmen, 54.2% in sophomores, 51.3% in juniors and 50% in seniors. The portion of subjects who had vitamin D deficiency in our study was congruent with some of the previous studies conducted in western countries and Korea (Burke, Reilly, Morrell, & Lofgren, 2009; Hall et al., 2010; Lee, 2013). Previous study has shown that vitamin D deficiency is closely related to calcium deficiency especially in young women due to the tendency of calcium-rich foods being rich in vitamin D as well (Raiten & Picciano, 2004). Further analysis of our data has shown a congruent result, where 72.6% of calcium deficient subjects also showed deficiency in vitamin D intake. Significant average t-score differences were noted among daily milk consumers and non-daily consumers during high school and current

days. However, for the milk and other dairy product intakes, our subjects showed similar patterns with the national data and the Japanese data, where more than 70% of the subjects were not engaged in daily consumption. This may be explained by a considerably low intake of dairy products among Asian cultures compared to other western and European cultures (Wetmore, Ichikawa, LaCroix, Ott, & Scholes, 2008).

The nutritional status and body compositions of our subjects were comparable to that of previous western and Korean studies. Although the average nutritional status of the subjects (BMI) was similar to previous studies, differences were noted in the specific body compositions. Compared to a western study, our subjects had lower weight, body fat mass, skeletal muscle mass and percent body fat (Nieves et al., 2010). This may be closely linked to lower portion of subjects involvement in exercise that the western country. Compared to a previous Korean study, our subjects had heavier weight, body fat mass, skeletal muscle mass and percent body fat (Hong et al., 2012). This difference may also have been related to subjects' involvement in regular exercise. Although a large number of our students were not involved in regular exercise, Hong's subjects may have had even larger number of students lacking exercise.

We found a general lack of exercise among the subjects. Previous studies reported that about 20 minutes of modest impact activity or resistance training three times a week can improve bone mineral density (Kai, Anderson, & Lau, 2003; Price, Langford, & Liporace, 2012). However, our study showed only 36.9% of subjects to be engaged in regular exercise which was much lower than those reported in previous studies on female college students in

western countries (Elgan, Dykes, & Samsioe, 2002; Marwaha et al., 2011). Also, our subjects had less weekly hours spent on outdoor activities than that of western studies (Nieves et al., 2010; Marwaha et al., 2011). This difference between Korean and western students was similar to that of previous Korean studies, indicating a lack of exercise among Korean females (Kang, 2009; Lee, Lee, & Kim, 2011). Furthermore, our subjects showed much greater lack of exercise than previous Korean studies. Our study has shown that among non-regular exercisers, 90 (89.1%) students were not participating in any exercise at all on a weekly basis. This was much higher than that of previous Korean study (76%) (Lee, Lee, & Kim, 2011). Also, the average weekly frequency of exercise was lower in our subjects compared to previous Korean studies (2.25±0.58; 2.15±1.02) (Chon, Jeon, & Kim, 2012; Lee, Lee, & Kim, 2011). This may be partly due to our students' engagement in clinical practicums as they advance within the nursing school curriculum which cause a lack of time for exercise. Our hypothesis was supported by further analysis. We found that there was a tendency of a decrease in the weekly frequency of exercise as the grade level increased, which was congruent with some of the previous studies (Buckworth & Nigg, 2004; Egli, Bland, Melton, & Czech, 2011). Freshmen were engaged in more frequent exercise (p=.06) and spent more hours on outdoor activities (p=.01) than sophomores, and they also spent more hours on outdoor activities (p=.03) than juniors. A further investigation was conducted on students in relation to an involvement in regular exercise. Although there was no significant difference in BMD between the students who are involved in regular exercise and those who are not, some differences were noted in lifestyle patterns, body composition and dietary intakes between the two

groups. Regularly exercising students tended to have less daily caffeine intakes (p=.06), spend more time on weekly outdoor activities (p=.07), had significantly more frequent weekly exercise (p<.00), tended to weigh more (p=.08), had significantly more skeletal muscle mass (p=.01), and tended to have higher intakes of vitamin C (p=.09) and zinc (p=.08). Although regular exercise was not a significant determinant factor that is directly related to BMD in our subjects, it was interesting to find that an involvement in regular exercise was found to be positively correlated with other factors that are reported to strengthen BMD.

We found that the average *t*-score of our subjects was slightly higher that some of the reported values in previous studies in Korea that used the same BMD measuring methods (J.H. Choi & Kim, 2008; C. Kim & E. M. Kim, 2010). This discrepancy may have resulted from considerably favorable body composition and nutritional intakes of our subjects. Our subjects had heavier weight, body fat mass, skeletal muscle mass, percent body fat and BMI than that of previous studies'. Also, the average intakes of total energy (Kcal), protein and calcium were much higher in our subjects. However, due to our study limitation of having such a small portion of students with osteopenic and osteoporotic *t*-scores, very few variables were noted to have significant relationship with BMD.

Because our study was limited to students attending to one college and majoring in a specific study, it is hard to generalize the results to all of the Korean female college students. However, it should be noted that this study included all grade levels of students. Also, given that all subjects were majoring in nursing and, therefore, had more exposure to health information, it

is interesting that the subjects had low compliance to health-promoting lifestyle behaviors.

VI. Conclusion

This study was a cross-sectional study conducted to investigate the effect past and current lifestyle patterns, dietary intake, nutritional status and body composition on Korean female college students' BMDs.

The study was conducted from June, 2013 to October, 2013 on 160 female college students enrolled in SNU College of Nursing. The summary of the study results are as of the following:

1) 90% of the Korean female college students were engaged in caffeine consumption
2) 63.1% of the Korean female college students were not involved in regular exercise.
3) Breakfast and milk consumptions have a positive effect on increasing BMD.
4) Lifestyle patterns including milk consuming behavior and exercising during elementary school and high school positively affect BMD in college years.
5) Korean female college students tend to have unfavorable dietary intake habits with low vitamin D, vitamin C, biotin, calcium, chlorine, potassium, magnesium and iodine intakes and high sodium, fluorine and cholesterol intakes.
6) BMI, weight, skeletal muscle mass, body fat mass and percent body fat have a positive effect on increasing BMD.

From these study results, suggestions for future research are as of the followings:

1) Longitudinal studies that investigate bone-related lifestyle patterns starting from childhood up to early adulthood should be established.
2) Studies that promote regular exercise female college students should be established.
3) Studies investigating specific reasons for bone-promoting nutrient deficiency in Korean female college students and promoting intakes should be established.

VII. Reference

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VIII. Appendix 1

설문지

안녕하십니까?

본 설문지는
‘한국 여대생의 영양상태, 식이 섭취 및 생활 습관이 골밀도에 미치는 영향’ 의 연구용으로 사용하기 위한 자료입니다.

이 연구의 조사내용은 오직 연구 목적으로만 사용되며
자세히 기록하여 주시면 감사하겠습니다.

바쁘신 가운데 번거롭게 해드려 대단히 죄송하오며,
협조해 주셔서 감사합니다.

ID	
이름	
날짜	
연락처	

1. 연구 참여 동의서– [참여자 보관용]

연구 제목: The effects of nutritional status, dietary intake and lifestyle habits on bone mineral density in Korean female college students

본 연구는 서울시내에 있는 간호대학교에서 총 120명의 대학생을 대상으로 골밀도에 영향을 미치는 관련인자들과 골밀도와의 상관관계를 분석해 보기 위한 연구입니다. 본 연구는 자발적으로 참여 의사를 밝히신 분에 한하여 수행될 것이고 연구에 참여하신 후에도 언제든지 그만두실 수 있습니다.

연구에 참여하시게 되면 신장, InBody측정, 골밀도 측정 및 설문 조사를 하시게 됩니다. **위의 조사를 받기 전 주 3일 동안 (주중 2일, 주말 1일) 식이일지 (food diary)를 작성해 오시면 됩니다. 작성하신 식이일지는 설문조사 시 확인을 해드릴 예정입니다.** 검사와 설문 조사를 하시는데 소요되는 시간은 한 시간 정도가 걸릴 예정이고 본 연구에 시간을 내어 참여해주신 답례로 참여자분의 현재 건강상태를 파악할 수 있으며 추후 골밀도 증진, 유지 및 골다공증 예방을 위한 자료가 될 수 있는 Inbody와 골밀도 측정 결과와 영양소별 섭취상태를 교육 받으시게 되며 소정의 선물을 제공하여 드립니다.

연구에 참여해주시는 대상자분의 신상에 관한 정보는 이름과 전화번호로 제한되며, 수집된 모든 정보는 연구책임자 1인과 연구 보조원 1인만이 알 수 있도록 처리하여 잠금 장치가 있는 곳에 보관하고 연구 논문이 인쇄자료로 발표된 후에는 분쇄 폐기 처리될 것입니다.

연구에 참여하여 주셔서 감사합니다.

"본인은 이 연구에 대한 설명을 충분히 들었으며, 이 연구에 참여할 것을 동의합니다. 본인은 자발적으로 이 연구에 참여하고 있음을 알고 있습니다."

성명:_____(서명)　　날짜:___/___/___

이 연구는 서울대학교 간호대학 연구대상자 보호 심사 위원회의 승인을 받았습니다.

- 연구 책임자: 서울대학교 간호대학 **박다인**
- 연구 책임자 연락처: 02-740-8454

2. 연구 참여 동의서– [연구자 보관용]

연구 제목: The effects of nutritional status, dietary intake and lifestyle habits on bone mineral density in Korean female college students

본 연구는 서울시내에 있는 간호대학교에서 총 120명의 대학생을 대상으로 골밀도에 영향을 미치는 관련인자들과 골밀도와의 상관관계를 분석해 보기 위한 연구입니다. 본 연구는 자발적으로 참여 의사를 밝히신 분에 한하여 수행될 것이고 연구에 참여하신 후에도 언제든지 그만두실 수 있습니다.

연구에 참여하시게 되면 신장, InBody측정, 골밀도 측정 및 설문 조사를 하시게 됩니다. **위의 조사를 받기 전 주 3일 동안 (주중 2일, 주말 1일) 식이일지 (food diary)를 작성해 오시면 됩니다. 작성하신 식이일지는 설문조사 시 확인을 해드릴 예정입니다.** 검사와 설문 조사를 하시는데 소요되는 시간은 한 시간 정도가 걸릴 예정이고 본 연구에 시간을 내어 참여해주신 답례로 참여자분의 현재 건강상태를 파악할 수 있으며 추후 골밀도 증진, 유지 및 골다공증 예방을 위한 자료가 될 수 있는 Inbody와 골밀도 측정 결과와 영양소별 섭취상태를 교육 받으시게 되며 소정의 선물을 제공하여 드립니다.

연구에 참여해주시는 대상자분의 신상에 관한 정보는 이름과 전화번호로 제한되며, 수집된 모든 정보는 연구책임자 1인과 연구 보조원 1인만이 알 수 있도록 처리하여 잠금 장치가 있는 곳에 보관하고 연구 논문이 인쇄자료로 발표된 후에는 분쇄 폐기 처리될 것입니다.

연구에 참여하여 주셔서 감사합니다.

"본인은 이 연구에 대한 설명을 충분히 들었으며, 이 연구에 참여할 것을 동의합니다. 본인은 자발적으로 이 연구에 참여하고 있음을 알고 있습니다."

성명:_____(서명)　　날짜:___/___/___

이 연구는 서울대학교 간호대학 연구대상자 보호 심사 위원회의 승인을 받았습니다.

- 연구 책임자: 서울대학교 간호대학 **박다인**
- 연구 책임자 연락처: 02-740-8454

I. 신체계측

1. 키: _____cm

2. 체중:_____kg

3. BMI _____kg/m^2

4. Body fat mass _____kg

5. Skeletal muscle mass _____kg

6. Body fat percentage _____%

	①		②	
7. 골밀도	측정부위	Rt / Lt	측정부위	Rt / Lt
	Stiffness Index		Stiffness Index	
	T-score		T-score	
	Z-score		Z-score	

II. 일반적 사항

1. 나이	만 _____세
2. 성별 (동그라미 치세요)	(여자) (남자)
3. 현재 학년	대학교_____학년
4. (2번이 여자일 경우) 초경연령	만 _____세
5. 월 용돈 (한달 동안 지출액)	□ 0 ~ 10 만원 □ 11 ~ 20 만원 □ 21 ~ 30 만원 □ 31 ~ 40 만원 □ 41 ~ 50 만원 □ 51 만원 이상
6. 현재 거주 공간	□ 집 (본가) □ 기숙사 □ 자취 □ 친척집 □ 그 외:
7. 동거인	□ 부모님 포함한 가족 □ 형제, 자매, 남매끼리 □ 룸메이트 □ 혼자

III. 건강상태

1. 본인이 의사에게 진단받은 질환 (전신 질환)	
2. 본인의 뼈 질환 진단 여부	(유) (무)
3. (2번이 '유' 인 경우) 의사에게 진단받은 질병명	
4. 골다공증 가족력 (동그라미 치세요)	(유) (무)
5. (4번이 '유' 일 경우) 가족 중 현재 골다공증을 앓고 있는 사람은?	
6. 골절 경험	(유) (무)
7. (6번이 '유' 일 경우) 골절 경험 나이	만 _____세
8. (6번이 '유' 일 경우) 골절 부위	
9. 현재 흡연 여부	(예) (아니오)
10. (9번이 '예' 일 경우) 하루 흡연 담배 양과 지금까지 흡연 기간	하루 담배_____개피 지난_____ 달/년 동안
11. 과거 흡연 여부	(예) (아니오)
12. (11번이 '예' 일 경우) 과거 흡연 시 담배 양과 과거 흡연 기간	하루 담배_____개피 _____달/년 동안

13. 음주 여부	(예) (아니오)
14. (13번이 '예 일 경우) 일주일 간 음주 빈도, 종류와 양	일주일 _____ 회/주 종류 □ 소주 □ 맥주 □ 막걸리 □ 포도주 □ 양주 □ 기타 양 (1회 음주 시 섭취량) □ 1잔 □ 2잔 □ 3잔 □ 4잔 □ 5잔이상
15. 카페인 섭취 여부 (커피, 차, 핫식스, 탄산음료 포함)	(예) (아니오)
16. (15번이 '예' 일 경우) 섭취 카페인 종류	
17. (15번이 '예' 일 경우) 섭취 카페인 종류별 하루 섭취 양과 빈도	종류 하루 _____잔 하루 _____회 종류 하루 _____잔 하루 _____회 종류 하루 _____잔 하루 _____회 종류 하루 _____잔 하루 _____회 종류 하루 _____잔 하루 _____회
18. 현재 다이어트 여부	(예) (아니오)
19. (18번이 '예' 일 경우) 다이어트의 목적	(1) 체중 감소 (미적 이유) (2) 특정 질환 때문에
20. 현재 규칙적인 운동 여부	(예) (아니오)

21. (20번이 '예' 일 경우) 운동의 종류와 빈도	□ 경도의 운동 (산책, 골프 등) – 운동횟수_____회/week – 1회 평균 운동 시간_____분 □ 중증도의 운동 (조깅, 자전거 등) – 운동횟수_____회/week – 1회 평균 운동 시간_____분 □ 격렬한 운동 (빠르게 달리기, 스피닝, 필라테스 등) – 운동횟수_____회/week – 1회 평균 운동 시간_____분
22. 현재 복용하는 약물 여부 (여자일 경우, 피임약 복용도 포함)	(예) (아니오) 약물 이름 및 용도:
23. 과거 정기적으로 처방 받고 복용한 약물 (예: 성장호르몬 주사)	(예) (아니오) 약물 이름 및 용도:
24. 선크림 사용 여부	(예) (아니오)
25. (23번이 '예' 일 경우) 사용 선크림의 SPF 지수와 사용횟수	_____SPF _____회/week
26. 한 주 당 평균 야외 활동 시간	주 _____시간

IV. 과거 식이 및 운동

1. 아침식사 여부	1) 초등학교: □ ① 매일------ 주 7회 아침식사 □ ② 가끔------주 2-3회 아침식사 □ ③ 안 함------ 주 0회 아침식사
	2) 중학교: □ ① 매일------- 주 7회 아침식사 □ ② 가끔------ 주 2-3회 아침식사 □ ③ 안 함------ 주 0회 아침식사
	3) 고등학교: □ ① 매일------- 주 7회 아침식사 □ ② 가끔------ 주 2-3회 아침식사 □ ③ 안 함------ 주 0회 아침식사
	4) 현재: □ ① 매일------- 주 7회 아침식사 □ ② 가끔------ 주 2-3회 아침식사 □ ③ 안 함------ 주 0회 아침식사
2. 우유 섭취 여부	1) 초등학교: □ ① 매 끼니-- 주 14-21회 우유 섭취 □ ② 매일------ 주 7회 우유 섭취 □ ③ 매 주--- -주 1회 우유 섭취 □ ④ 주 1회 이하 우유 섭취
	2) 중학교: □ ① 매 끼니-- 주 14-21회 우유 섭취 □ ② 매일------ 주 7회 우유 섭취 □ ③ 매 주--- -주 1회 우유 섭취 □ ④ 주 1회 이하 우유 섭취
	3) 고등학교: □ ① 매 끼니-- 주 14-21회 우유 섭취 □ ② 매일------ 주 7회 우유 섭취 □ ③ 매 주--- -주 1회 우유 섭취 ④ 주 1회 이하 우유 섭취

	4) 현재: □ ① 매 끼니-- 주 14-21회 우유 섭취 □ ② 매일------ 주 7회 우유 섭취 □ ③ 매 주--- -주 1회 우유 섭취 □ ④ 주 1회 이하 우유 섭취
3. 우유 외 유제품 섭취 여부 (치즈, 요구르트, 요플레, 생크림, 버터 등)	1) 초등학교: □ ① 매 끼니-주 14-21회유제품 섭취 □ ② 매일---- 주 7회 유제품 섭취 □ ③ 매 주---- 주 1회 유제품 섭취 □ ④ 주 1회 이하 유제품 섭취
	2) 중학교: □ ① 매 끼니-주 14-21회유제품 섭취 □ ② 매일---- 주 7회 유제품 섭취 □ ③ 매 주---- 주 1회 유제품 섭취 □ ④ 주 1회 이하 유제품 섭취
	3) 고등학교: □ ① 매 끼니-주 14-21회유제품 섭취 □ ② 매일---- 주 7회 유제품 섭취 □ ③ 매 주---- 주 1회 유제품 섭취 □ ④ 주 1회 이하 유제품 섭취
	4) 현재: □ ① 매 끼니-주 14-21회유제품 섭취 □ ② 매일---- 주 7회 유제품 섭취 □ ③ 매 주---- 주 1회 유제품 섭취 □ ④ 주 1회 이하 유제품 섭취
3. 운동 여부	1) 초등학교: □ ① 주 ≥10시간 이상 운동 □ ② 주 5-10 시간 운동 □ ③ 주 2-5시간 운동 □ ④ 주 1-2시간 운동 □ ⑤ 주 <1시간 이하 운동
	2) 중학교: □ ① 주 ≥10시간 이상 운동 □ ② 주 5-10 시간 운동 □ ③ 주 2-5시간 운동 □ ④ 주 1-2시간 운동 □ ⑤ 주 <1시간 이하 운동

	3) 고등학교: □ ① 주 ≥10시간 이상 운동 □ ② 주 5-10 시간 운동 □ ③ 주 2-5시간 운동 □ ④ 주 1-2시간 운동 □ ⑤ 주 <1시간 이하 운동
	4) 현재: □ ① 주 ≥10시간 이상 운동 □ ② 주 5-10 시간 운동 □ ③ 주 2-5시간 운동 □ ④ 주 1-2시간 운동 □ ⑤ 주 <1시간 이하 운동

IX. Appendix 2

Food diary　　주 조리자 □ ① 본인 □ ② 배우자 □ ③ 자녀 □ ④ 기타

식사기록의 예				1 일째 (날짜:_____월_____일_____요일)	
		음식 이름(재료 이름)	먹은 양	음식 이름(재료 이름)	먹은 양
아 침	밥	쌀 밥	1 공기		
	국/찌개	미 역 국	1 대접		
	반찬	시금치 나물 꽁 치 구 이 김 구 이	5 젓가락 1 토막 5 장		
	김치	배 추 김 치	1 접시		
	간식	커피	1 컵		
점 심	밥	보 리 밥	1/2 공기		
	국/찌개	김 치 찌 개	1/2 대접		
	반찬	고등어 조림 멸 치 볶 음	1/2 토막 3 젓가락		
	김치	깍두기	5 개		
	간식	사 과	1/2 개		
저 녁	밥	잡 곡 밥	1/3 공기		
	국/찌개	조개 된장국	1 대접		
	반찬	삼 겹 살 상 추 쌈	1 인분 10 장		
	김치	열 무 김 치	1 젓가락		
	간식	방울 토마토	10 개		

야식		맥주 (카스)	500ml		
	2 일째 (날짜:_____월_____일_____요일)			3 일째 (날짜:_____월_____일_____요일)	
		음식 이름(재료 이름)	먹은 양	음식 이름(재료 이름)	먹은 양
아침	밥				
	국/찌개				
	반찬				
	김치				
	간식				
점심	밥				
	국/찌개				
	반찬				
	김치				
	간식				
저녁	밥				
	국/찌개				
	반찬				
	김치				
	간식				
야식					

X. 국 문 초 록

골다공증은 전 세계적으로 문제가 되고 있는 질환 중 하나이며 완치가 불가능하고 골밀도가 저하되었을 때에 골절과 같은 증상을 통해 발견되기 때문에 예방에 초점을 맞추어야 한다. 골밀도 형성 및 증가는 탄생 후부터 꾸준히 지속되다가 20-30세 쯤 최대 골질량 (maximal peak bone mass)을 도달하였을 때부터 점차적으로 감소하게 된다. 따라서 20대 초,중반 시기까지 골밀도를 최대한 높이는 것이 골다공증 예방의 최상의 방법이라고 할 수 있다. 골밀도 형성에 영향을 미칠 가능성을 갖고 있는 것으로 알려져 있는 요인으로는 생활습관, 식이섭취 그리고 신체 조성이 있다. 이에 본 연구는 현재 한국 여대생의 골밀도, 생활습관, 식이섭취 및 신체 조성을 서술적으로 평가하고 이러한 요인들과 골밀도와의 관계를 조사하고자 하였다.

서울시 소재 일개 간호대학에 재학 중인 여대생 전 학년 중 160명을 대상으로 골밀도, 생활습관, 식이섭취 및 체성분을 측정하여 평가하였다. 자료 수집은 2013년 6월 10일에서 10월 25일까지 시행되었다. 골밀도에 관한 자료를 위해 종골 초음파 골밀도 측정기를 사용하였고, 대상자 특성, 과거와 현재의 생활습관과 식이섭취에 관한 자료를 위해 일대일 면담, 설문조사, 식이기록법과 24시간 회상기법을 이용하였고, 신체 조성에 관한 자료를 위해 InBody 720 체성분 분석 기계를 사용하여 측정하였다. 수집된 자료는 Windows SPSS 20.0 program을 이용하여 기술통계, t-test, chi-square test, one-way ANOVA로 분석하였다,

연구 결과는 다음과 같다.

여대생의 평균 골밀도는 (t-score) 0.37 ($\pm$1.26)이였고, 이 중 정상

군에 속하는 학생이 128명 (80%)이였고, 비정상군에 속하는 학생이 32명 (20%)이였다.

현재 규칙적인 운동을 하는 학생이 59명으로 총 대상자 수의 36.9%였고, 평균적으로 주 1.25 (±1.58)회 운동을 하며, 주 11.6 (±9.17)시간을 야외 활동에 투자하고 있었다. 과거와 현재 주 운동 시간을 조사하여 고 빈도 군 (>5h/wk)과 저 빈도 군 (≤5h/wk)으로 나눈 결과, 고 빈도 군에 속하는 학생이 초등학교 때에는 71명 (44.4%), 중학교 때에는 43명 (26.9%), 고등학교 때에는 22명 (13.8%), 그리고 현재에는 24명 (15%)으로 점차적으로 감소함을 알 수 있었다. 현재 카페인 섭취를 하는 학생은 144명으로 전체 대상자의 90%를 차지하였다. 이 학생들은 평균적으로 하루 1.69 (±0.95)회 카페인 섭취를 하였다. 조식섭취의 경우, 고 빈도 군 (조식 섭취)과 저 빈도 군 (조식 결식)으로 나누었다. 고 빈도 군에 속하는 학생이 초등학교 때에는 151명 (94.4%), 중학교 때에는 146명 (91.3%), 고등학교 때에는 148명 (92.5%), 그리고 현재에는 109명 (68.1%)명으로 조식 섭취률이 점차적으로 감소함을 알 수 있었다. 우유 섭취와 그 외 유제품 섭취 또한, 고 빈도 군 (매일 섭취)이 점차적으로 감소하였다. 고 빈도 우유 섭취의 경우, 초등학교 때에는 129명 (80.6%), 중학교 때에는 88명 (55%), 고등학교 때에는 62명 (38.8%) 그리고 현재에는 38명 (23.8%)이였다.

주중 2일과 주말 1일을 포함한 3일 식이기록법, 24시간 회상기법과 Can-Pro 4.0을 통하여 분석하여 각 영양소 별 권장량 섭취를 충족시킨 군, 결핍 군과 과잉 섭취 군으로 나누었다. 학생들 중 137명이 (85.6%) 나트륨을 과잉섭취 하고 있었고, 86명이 (53.8%) 콜레스테롤을 과잉섭취

하고 있었다. 하지만 109명이 (68.1%) 식이섬유 권장량 섭취를 충족시켰으며 81명이 (50.6%) 비타민 C 권장량 섭취를 충족시켰다. 104명 (65%)의 학생이 비타민 D 결핍을 보였으며, 84명 (52.5%)이 칼슘 결핍을 보였다.

신체 조성의 경우, 학생들의 평균 BMI는 21.3kg/m^2 (±1.97)이였고, 115명 (71.8%)이 정상군, 11명이 (6.9) 저체중 군, 34명이 (21.3%)가 과체중 군에 속했다. 체지방율의 경우, 평균 30.1%(±4.18)이였고, 112명 (70%)이 정상 군, 4명 (2.5%)이 저 체지방 군, 44명 (27.5%)이 고 체지방 군으로 나뉘었다. 복부지방률은 평균 0.81 (±0.03)으로 135명 (84.4%)이 정상 군 그리고 25명 (15.6%)이 복부 비만 군에 속했다.

대상자들을 골밀도 정상 군과 비정상 군으로 나누었을 때 유의한 차이 혹은 경향을 보인 변수들은 다음과 같다. 생활습관 중에서는 주 당 운동 횟수와 (p=.05) 하루 카페인 섭취 횟수 (p=.07)였다. 또한, 초등학교 때의 주 당 운동 시간 (p=.07), 고등학교 때 (p=.05)와 현재의 (p=.02) 우유 섭취 그리고 현재 조식 섭취 여부 (p=.07)에서 t−score의 차이가 있었다. 식이 섭취의 경우, 비타민 B5 (p=.07)와 copper (p=.03)만이 통계적으로 유의한 차이를 나타냈다. 신체 조성에서는 BMI (p=.06)와 키 (p=.03)에서 유의한 차이를 나타냈다.

본 연구 결과 한국 여대생들 중 간호대에 재학 중인 여대생의 경우, 운동 횟수와 카페인 섭취가 골밀도에 부정적인 영향을 미침에도 불구하고 규칙적인 운동의 부족이 있었고, 하루 평균 2잔정도의 지속적인 카페인 섭취를 하고 있음을 확인할 수 있었다. 고등학교 시절을 포함한 과거부터 현재까지의 우유 섭취가 골밀도에 긍정적인 영향을 미치지만, 우유섭취 빈도가

과거부터 현재까지 점차적으로 줄어드는 양식을 보였다. 현재 조식 섭취 여부 또한 골밀도에 좋은 영향을 미치는 요인으로 확인 되었으나, 과거에 비해 현재 조식 섭취율이 감소했음을 나타냈다. 식이 섭취의 경우, 과반수의 대상자가 전반적인 건강에 악영향을 미치는 나트륨과 콜레스테롤을 과잉 섭취하고 있었다. 골밀도 증가에 영향을 미친다고 알려져 있는 비타민 D와 칼슘섭취 결핍인 학생 또한 과반수였다.

따라서 한국 여대생의 골밀도를 포함한 전반적인 건강상태를 증진시키기 위해서는 골밀도를 강화시키고 전반적인 신체 조성에 긍정적인 영향을 미치는 꾸준하고 규칙적인 운동을 강화시키고, 카페인 섭취량을 감소시키고, 우유 섭취, 조식 섭취, vitamin D와 칼슘 섭취를 늘리고 콜레스테롤과 나트륨 섭취를 낮추는 포괄적인 중재 또는 프로그램을 강구해야 할 것으로 생각된다.

주요어: 여대생, 골밀도, 생활습관, 식이섭취, 신체 조성

학번: 2012-20426

간호학 석사학위논문

Lifestyle patterns, dietary intakes and body compositions of Korean female nursing students and their relations to bone mineral density

2014년 2월

서울대학교 대학원

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Lifestyle patterns, dietary intakes and body compositions of Korean female nursing students and their relations to bone mineral density

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이 논문을 간호학석사 학위논문으로 제출함
2013년 10월

서울대학교 대학원
간호학과 간호학 전공
박 다 인

박다인의 간호학석사 학위논문을 인준함
2013년 12월

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Abstract

Osteoporosis is one of the leading global health problems with no definitive cure available. It is usually diagnosed when one has fracture due to dramatically decreased bone mineral density (BMD). Peak bone mass (PBM) is established during one's late-20s. Once PBM is reached, the BMD slowly deteriorates over lifetime period. Therefore, an effort to maximize PBM should be established for osteoporosis prevention. It has been reported that lifestyle patterns, dietary intakes and body compositions have effects on BMD formation. Therefore, this study aims to describe Korean female nursing students' current BMD, lifestyle patterns, dietary intakes, body compositions and their relations to BMD.

A total of 160 female students attending to a nursing school at a college in Seoul, Korea were evaluated. Data collection took place from June 10th to October 25th of 2013. An ultrasonometer was used to determine BMD, one-on-one interview, survey, 24-hour recall and food diary methods were used to determine general characteristics, past and current lifestyle patterns and dietary intakes. An InBody 720 machine was used to analyze body compositions. Data were analyzed using Windows SPSS 20.0 program.

The results are as of the followings:

The average BMD (*t*-score) of the students was 0.37 (±1.26), and among these students 128 (80%) was in the normal range and 32 (20%) were in the below the normal range.

Currently, 59 students (36.9%) were involved in regular exercise, and they

spend about 1.25 (±1.58) times per week on exercising and spent 11.6 (±9.17) hours per week on outdoor activities. When students were divided into a high frequency group (>5h/wk) and a low frequency group (≤5h/wk) according to their past and current exercise hours, the number of students in the high frequency group were as of the followings: elementary school (71, 44.4%), middle school (43, 26.9%), high school (22, 13.8%) and current (24, 15%).

Students were divided into 3 groups according to the analysis of their food diaries: adequate, deficient and excessive. A total of 137 (85.6%) students had excessive sodium intakes and 86 (53.8%) had excessive cholesterol intakes. However, 109 (68.1%) had adequate fiber intake and 81 (50.6%) had adequate vitamin C intakes. Vitamin D deficiency was noted in 104 (65%) students, and calcium deficiency was noted in 84 (52.5%) students.

As for the body composition, the average BMI of the students, an indicative of their nutritional status, was 21.3kg/m^2 (±1.97). The students were divided into 3 groups according to their BMIs: normal (115, 71.8%), underweight (11, 6.9%) and overweight (34, 21.3%).

When the students were divided into 'normal BMD' and 'below the normal BMD' groups, variables that showed significant findings are as of the followings. Among lifestyle patterns, weekly exercise frequency (p=.05) and daily caffeine consumption (p=.07) showed significant differences between the groups. Also, weekly exercise hours during elementary school (p=.07), milk consumption during high school (p=.05) and current days (p=.02), and current breakfast consumption (p=.07) showed significant BMD differences. Only vitamin B5 (p=.07) and copper (p=.03) were significant among nutrients analyzed from the dietary intakes. As for the body compositions, BMI (p=.06)

and height (p=.03) showed significant differences.

This study showed that despite the fact that exercise frequency and caffeine consumption have effects on BMD, a large number of Korean female nursing students were not engaged in regular exercise and were consuming about 2 cups of caffeine daily. Although past and current milk intakes have a positive effect on BMD, our subjects showed a decreasing trend in milk consumption as they progressed from childhood into the adulthood. More than half of the subjects had excessive intakes of sodium and cholesterol that are known to have negative effects on general health. Also, more than half of the subjects had deficiency in vitamin D and calcium intakes.

Therefore, in order to strengthen Korean female college students' BMD, there is a need for comprehensive interventional programs that reinforces regular exercise, reduces caffeine, sodium and cholesterol intakes, and increases milk, breakfast, vitamin D and calcium intakes.

Key word: female college students, bone mineral density, lifestyle, dietary intake, body compositions

Student ID: 2012-20426

Contents

1. Introduction

Osteoporosis is one of the leading global health problems expected to affect more people at various age ranges (Ford, Bass, Zhao, Bai, & Zhao, 2011; Holroyd, Harvey, Dennison, & Cooper, 2012; "International Osteoporosis Foundation," 2013; Kohri et al., 2012; Rivas et al., 2012). It results in a subsequent increase in bone fragility and a susceptibility to fractures (Ford, Bass, Zhao, Bai, & Zhao, 2011). Due to an absence of a definitive cure, prevention is a key component in reducing the complications of low bone mineral density (BMD). Bone mass accumulation is steadily achieved until age 20-30 when the maximal peak bone mass (PBM) is acquired, which is the amount of bony tissue present at the end of the skeletal maturation (Bonjour, Theintz, Law, Slosman, & Rizzoli, 1994; D. S. Cho & Lee, 2008; Pampaloni et al., 2013).

Although until recent years, postmenopausal women were thought to be the most vulnerable population, there has been a tendency of an increase in osteoporosis diagnosis in women in their 20s-30s in Korea ("Health Insurance Review & Assessment Service," 2012). However, most of the previous research studies on osteoporosis and BMD have focused on perimenopausal, postmenopausal or elderly women. The very few previous studies on BMD in young adult women only focused on some of the modifiable factors or only focused on athletic women and, thus, lacked to provide the level of BMD and BMD modifying factors for average, non-athletic female college students (D. S. Cho, & Lee, J. Y, 2008; J. H. K. Cho, Soon Kyung, 2008).

Although about 50-70% of the variance in BMD within a population is determined by genetic factors, other manageable environmental determinants such as lifestyle patterns, dietary intakes, nutritional status and body compositions influence bone mass maturation (D. S. Cho & Lee, 2008; Marwaha et al., 2011; Nieves et al., 2010; Weaver, 2008).

Previous studies reported that exercise has a positive influence on bone health in various age groups (Allison, Folland, Rennie, Summers, & Brooke-Wavell, 2013; Balsamo et al., 2013; Marwaha et al., 2011). These studies suggest that an involvement in regular exercise contributes a significant BMD gain. Moreover, they have shown that a constant and frequent involvement in moderate intensity exercise is beneficial in bone formation. Unfortunately, however, the number of Korean adult females who are engaged in walking, moderate and heavy exercises have decreased dramatically within the last 6 year period (*2011 5th National Health & Nutrition Survey*, 2011). On the other hand, caffeine consumption has been reported to have a negative influence on BMD determination (Harter et al., 2013; Krall & Dawson-Hughes, 1993; Wetmore, Ichikawa, LaCroix, Ott, & Scholes, 2008). Studies have shown that not only current but also observations of past lifestyle patterns allow the rate of change of BMDs and the prevalence and cumulative incidence of osteoporotic fractures (Dennison, Yoshimura, Hashimoto, & Cooper, 1998; Ishimoto et al., 2013; Yoshimura et al., 1998). But most of the previous BMD studies conducted on Korean female college students have only assessed current health behaviors and lifestyle patterns.

Moreover, among dietary components and nutrients that are associated

with bone growth, calcium has been identified as one of the leading factors that decide overall BMD (Bolton-Smith et al., 2007; S. A. Shin, Hong, Choi, Roh, & Joung, 2008; Weaver, 2008). Still, the 2010-2012 Korea National Health and Nutrition Survey indicated calcium as the most deficient nutrient in Korean adults over the age of 19 years, especially in women. Besides calcium, some of the other nutrients such as protein, fat and several kinds of vitamins may also have positive effects on BMD, but the results are controversial (J. H. Cho & Kim, 2008; S. Shin & Joung, 2013).

Previous studies have also shown that nutritional status and body compositions are closely linked to bone formation and BMD in various populations (Castillo & de la Rosa, 2009; Felson, Zhang, Hannan, & Anderson, 1993; C. Kim & E. Kim, 2010; Murillo-Uribe et al., 1998). Heavier body compositions exert positive effects on BMD through weight bearing effects on bone structure (Lanyon, 1992; Lim, Bae, Lee, & Ahn, 2008; Salamat, Salamat, Abedi, & Janghorbani, 2013). Specific body compositions such as skeletal muscle mass, body fat mass, percent body fat and their relations to BMD are still being debated (Gnudi, Sitta, & Fiumi, 2007; Lee, 2013b; H. Shin, Liu, Panton, & Ilich, 2013). Studies have shown that majority of Korean female college students tend to have unfavorable body compositions such as low BMI, low skeletal muscle mass and high body fat mass and percent body fat due to extreme weight loss from unhealthy dieting and lack of exercise, and are, therefore, exposed to nutritional imbalance that affects BMD (D. S. Cho, & Lee, J. Y, 2008; Hong, Pak, & Sohn, 2012).

Therefore, this study aimed, first, to investigate past and current

lifestyle patterns, dietary intakes, and nutritional status and body compositions of Korean female college students. Second, it aims to analyze the relationship between these modifiable contributing factors and BMD. The study results are expected to explore and establish a comprehensive understanding of BMD modifiable factors and to provide more in-depth understanding of reasons for steadily increasing number of Korean young adult women with low BMD.

1. Research purpose

The aim of this study was to investigate the modifiable contributing factors of BMD formation including past and current lifestyle patterns, dietary intakes, nutritional status and body compositions, and their relationship to BMD in Korean female college students. The specific purposes were as of the followings:

1) To investigate past and current lifestyle patterns of female college students
2) To investigate dietary intakes of female college students
3) To investigate nutritional status and body compositions of female college students
4) To analyze relationship between past and current lifestyle patterns of female college students and their BMD
5) To analyze relationship between dietary intakes of female college students and their BMD
6) To analyze relationship between nutritional status and body composition of female college students and their BMD

2. Terminology

1) Bone mineral density (BMD)

Bone mineral density is a heritable complex trait used as an important predictor of fracture risk, and indicator of bone strength and a clinical diagnostic measurement of osteoporosis (Hoy, Macdonald, & McKay, 2013; Rivadeneira et al., 2009; Yoon et al., 2012). BMD is expressed as *t*-score, which is a World Health Organization (WHO) recommended measure that indicates the amount of one's BMD deviating from healthy young adults' reference mean (Doshi, Khan, Williams, & Licata, 2013; Matkovic, 1992; Roig-Vilaseca, Nolla, & Roig-Escofet, 2000).Calculation of *t*-score was based on the following equation:

$$t - score = \frac{(\text{subject}'\text{sBMD} - \text{young adult BMD})}{(\text{Standard deviation of young adult BMD})}$$

2) Past and current lifestyle patterns

Lifestyle patterns are defined as a way of living of individuals which manifest in coping with their physical, psychological, social, and economic environments on a day-to-day basis (O'Halloran et al., 2001). In this study, lifestyle patterns included behaviors that are known to be associated with BMD. To assess periodical lifestyle patterns and their relations to BMD, past and current behaviors were measured using Lifestyle Factor Questionnaire (LFQ) that was used in Wakayama Medical University's study (Ishimoto et al., 2013). Past lifestyle patterns refer to subjects' bone health related behaviors during elementary, middle and high school years, and current refers to those of present days'.

3) Regular exercise

Subjects' involvement in regular exercise was defined as an involvement in exercise for 3 days a week of moderate intensity (Kelley, Kelley, & Kohrt, 2013a, 2013b; Liang et al., 2011). Regular exercise did not include daily activities and only included activities that involved physical movements to sustain or improve health and fitness (Evans, Racette, Van Pelt, Peterson, & Villareal, 2007)

4) Caffeine consumption

Caffeine consumption was defined as consumption of beverages that contain caffeine chemical compounds, including coffee, tea, soda and energy drinks (Al-Othman et al., 2012; C. Kim & E. Kim, 2010).

5) Dietary intakes

Dietary intakes are defined as the consumption of nutrients via food items, and this information was obtained from a 24-hour recall method and analyzed by using Can-Pro 3.0 (J. H. Cho & Kim, 2008).

6) Nutritional status

Nutritional status was determined by body mass index (BMI, kg/m^2), of the subjects (Ahn, 2005; D. S. Cho, & Lee, J. Y, 2008; Yoshimura et al., 1998). According to the BMI results, subjects were categorized into three categories: underweight, normal and overweight (*2011 National Health Survey*, 2012).

7) Body compositions

Body compositions refer to the relative proportion of protein, fat, and mineral components in the body (Lee, 2013b; "Mosby's medical dictionary," 2009) For this study, body compositions referred to anthropometric measurements determined by height, weight, skeletal muscle mass, body fat mass, percent body fat, waist-hip ratio, visceral fat area measured by a body composition analysis machine (InBody 720, Biospace body composition analyzer, Newcastle, NE, USA).

II. Literature Review

1. The importance of bone mineral density in young females

According to the Health Insurance Review & Assessment Service data, the number of osteoporosis patients in Korea increased from 535,000 in 2007 to 773,000 in 2011. For this five year period, there was a 44.3% increase in osteoporosis incidence rate with annual average increase of 9.7% and an 18.7 billion won increase in the total osteoporosis-related medical expenses, an increase from 53.5 billion in 2007 to 72.2 billion in 2011. When the number of patients treated for osteoporosis was analyzed according to sex, the male share was only 6.4~7.5% compared to the female share of 92.5~93.6%, indicating female vulnerability and susceptibility to osteoporosis.

Osteoporosis is known to be more prevalent in menopausal women in their 50s (K. H. Kim et al., 2012; Schoffl et al., 2008; Tatsuno et al., 2013). However, recent studies have shown an increased prevalence and incidence rates of osteopenia and osteoporosis in young adult women population (M. Kim & Lee, 2010; Lim et al., 2008). The annual number of socially active women in their 20s~30s affected by osteoporosis is about 10,000, and a 4.6% increase was shown in 20~29-year-old women within a 5 year period ("Health Insurance Review & Assessment Service," 2012).

The amount of bone tissue in the skeleton, known as bone mass, can keep growing until around late 20s to age 30 when the maximum strength and density of bones, known as PBM, is reached ("Osteoporosis: Peak bone mass in women," 2009). Previous studies have shown that women tend to experience minimal changes in total bone mass from age 30 to menopause, but

then experience a rapid bone loss in the first few years after menopause largely due to hormonal changes (J. H. Cho & Kim, 2008; Lim et al., 2008). This rapid loss of BMD can lead to fragile bone and osteoporosis development, and put them at a high risk for osteoporotic fractures (Song, Paik, & Joung, 2008). It has been reported that the bone health is determined by the level of bone density when the PBM is reached which acts as a presumptive factor indicating the rate and the degree of bone loss in the future (Bonjour, Chevalley, Ferrari, & Rizzoli, 2009; J. H. Cho & Kim, 2008; "Peak bone mass and bone loss in postmenopausal osteoporosis," 1991). The denser the PBM is, the lesser the likelihood is for a person to develop osteoporosis in late adulthood (J. H. Cho & Kim, 2008; Deere, Sayers, Rittweger, & Tobias, 2012). Therefore, establishing relatively high PBM during early adulthood, especially in female population, may be the best and the most important preventative solution in bone health promotion and osteoporosis prevention.

2. Lifestyle patterns, dietary intakes, nutritional status and body compositions that influence the BMD of female college students

Regular exercise has been reported to have an important role in increasing bone mass in a large quantity of previous studies in various age groups. An involvement in regular and moderate level exercise in perimenopausal women has been reported to have positive effects in both bone mass enhancement and maintenance (Schoffl et al., 2008). Also, it has been reported to help maximize the PBM in adolescent population (Deere et al.,

2012). Caffeine intake has been cited as a risk factor for osteoporosis, and it has been associated with inhibition of intestinal calcium absorption and increased urinary calcium excretion (Rizzoli, 2008). However, the mechanism underlying this association is incompletely understood, and the majority of reported studies of this association have been conducted among postmenopausal women (Al-Othman et al., 2012; Conlisk & Galuska, 2000; Wetmore et al., 2008). Even though young adult women may be an important group since they are in the process of attaining PBM, only few studies have examined this association among this group. Female college students are at the age group that has been reported to take the biggest portion of caffeine consumers in Korea (Park & Oh, 2013). Not only current lifestyle patterns mentioned above but also past lifestyle factors are linked to bone formation during early adulthood, and ultimately affect the risk of osteoporosis development in later life (Ishimoto et al., 2013).

According to the 2011 National Health & Nutrition Survey, daily calcium intake was only 72.9% of the recommended daily requirement and was identified as the most deficient nutrient. Except for the infants (1~5yo), all age groups showed calcium intake of less than 80% of the recommended daily requirement (*2011 5th National Health & Nutrition Survey*, 2011). These data suggest calcium, a nutrient that has been reported to have a direct effect on bone mass maintenance and BMD enhancement, as the nutrient most susceptible to deficiency. The fraction of calcium deficient subjects in women (70.7%) were twice larger than that of men's (*2011 5th National Health & Nutrition Survey*, 2011). If calcium intake is inadequate during bone mass

accumulation period, it may lead to a low BMD, which in turn, may cause osteoporosis in the late adulthood (Lim et al., 2008). Many previous studies have also shown low intake values in other dietary intakes such as total calorie, protein and vitamin D in Korean female college students (D. S. Cho & Lee, 2008; J. H. Cho & Kim, 2008; Lim et al., 2008). However, their relationships with BMD are still inconclusive and controversial.

Nutritional status and body compositions have been linked to BMD (D. S. Cho, & Lee, J. Y, 2008; Fosbol, Dupont, Alslev, & Zerahn, 2013; Saravi & Sayegh, 2013). BMI, one of the measurements that indicate nutritional status, has been reported to have a positive effect on BMD (C. Kim & E. Kim, 2010). Body compositions are reported to have effects on BMD, but the specific components and their associations with BMD are controversial (C. Kim & E. Kim, 2010; Lu et al., 2011). Due to frequently skipping meals, eating out and establishing irregular meal times, college students are at risk for nutritional imbalance (Lim et al., 2008). For female college students, their chance of nutritional imbalance further increases due to biased aesthetic criterion (Miyabara et al., 2007). Among Korean female college students, it has been reported that there is a high social tendency of skinny physique preference, which causes self-starvation and frequent, extreme, improper diet practices that leads to severe weight loss and nutritional imbalances (Hong et al., 2012). Such behaviors have effects on one's nutritional status and body compositions, and may cause a negative influence on BMD.

III. Method

1. Design

This study was a cross-sectional, descriptive correlational study conducted on Korean female college students to investigate their past and current lifestyle patterns, dietary intake, nutritional status and body composition and to analyze the relationships between these factors and their BMD.

2. Subject

All female students enrolled in Seoul National University's (SNU) College of Nursing program in the year of 2013 were recruited into the study. The inclusion and exclusion criteria were as of the following:

1) Inclusion criteria

(1) Female college student in aging between 19~29

(2) Able to comprehend survey questions and answer accordingly

(3) Able to comprehend the purpose of the study and are able to give consent autonomously.

2) Exclusion criteria

(1) Currently has or has a history of bone disorder

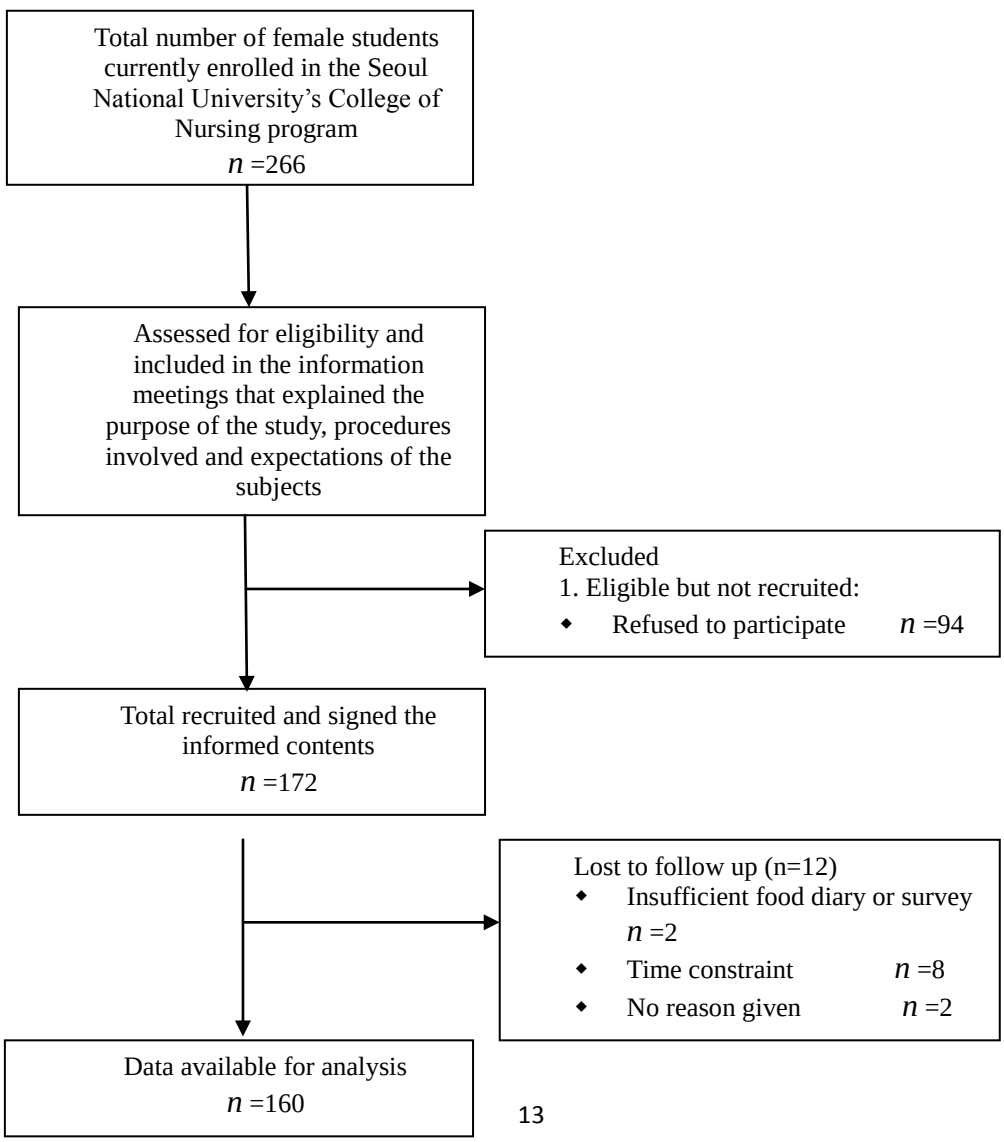
(2) Has parathyroid or thyroid disorder

(3) Has a surgical history that can directly impact on calcium metabolism such as esophagectomy or thyroidectomy.

(4) On a specific diet due to medication or medical regimen.

3) Sample

A total of 266 (93.3%) students were identified as females students currently enrolled in the SNU College of Nursing program. Initially, 172 (64.7% of the female nursing student population) students have agreed to participate in this study. However, among the initial participants, 12 (7.0 % of initial participants) students dropped out during the course of the study. Therefore, a total of 160 (60.9% of the female nursing student population) female students were selected as the final participants.



4) Sample size

Three different statistical test methods from G*Power 3.1.3 (G*Power, Faul & Erdfelder, Bonn, Germany) was used in order to determine the sample size of the study. First, in order to compare various variables' mean differences between a group of students with normal BMD and a group of students with at-risk BMD, *t*-tests with mean difference between two independent means (two groups) were selected as the test family and statistical test method with the following input parameters: two-tails, effect size (d) of 0.5, αerror probability of 0.05, power (1-βerror probability) of 0.80 and allocation ratio N2/N1 of 1. As a result, the program recommended the study to have a total sample size of 128. With a prediction of 10% dropout rate, the recommended study sample size was to at least be 141 subjects. Second, in order to compare mean *t*-scores related to past and current lifestyle frequencies, four different lifetime periods (elementary school, middle school, high school and current) were compared using ANOVA: fixed effects, omnibus, one-way statistical test with following the input parameters: effect size (f) of 0.4, αerror probability of 0.05, power (1-βerror probability) of 0.80 and number of groups of 4. As a result, the program recommended the study to have a total sample size of 76. With a prediction of 10% dropout rate, the recommended study sample size was to at least be 84 subjects. Last, in order to look at correlation between nutritional status and body compositions with BMD, correlation: bivariate normal model was selected with the following input parameters: two-tails, correlation p H1 of 0.3, αerror probability of 0.05, power (1-βerror probability) of 0.80 and correlation p H0 of 0. The recommended total sample size was 84,

and with 10% predicted dropout rate, at least 92 subjects were recommended for this study. With an actual dropout rate of 6.78% (*n*=12), the total number of subjects for this study was 160, fulfilling all three recommended sample sizes.

3. Measurement

1) General characteristics

Information on age, grade, menarcheal age, monthly allowance, residence, cohabitant(s), smoking habits, alcohol consumption, caffeine consumption, diet practice, regular exercise practice and use of sunscreen were measured by structured surveys. Medical histories, family history of osteoporosis, family members with osteoporosis, history of fracture and age at fracture were also measured by structured surveys.

2) Bone mineral density

A quantitative ultrasound (QUS) was used as the bone mass measuring method. QUS is a radiation-free, inexpensive, convenient and effective tool that provides information on bone microarchitecture assessing the overall bone strength and fracture risk (Alwis et al., 2010; Goh, Aragon, Lee, & Loke, 2011). The accumulation of bone mass measured at the calcaneus with QUS has been reported valid in reflecting one's overall BMD (Kohri et al., 2012; Matkovic, 1992). Therefore, in this study, BMDs of the subjects were measured using ultrasonic method (Achilles Express Ultrasonometer, GE Lunar Healthcare Corporation, USA) on subject's calcaneus. Calcaneus BMD

measurement using Achilles Express Ultrasonometer has been proven to have a diagnostic sensitivity comparable to dual-energy X-ray absorptiometry (DEXA) measurement of the spine and hip (Hans & Krieg, 2008; Krieg et al., 2008). This machine is the only QUS device cleared for monitoring bone changes by the Food and Drug Administration of United States(Gonnelli et al., 2002; Gonnelli et al., 1996). Calculated BMD measurements were expressed as *t*-scores. According to the *t*-score of subjects, they were, first, categorized as osteoporosis (*t* -score $\leq$ -2.5), osteopenia (-2.5 < *t* -score $\leq$ -1) or normal (*t* -score > -1) determined by the WHO's definitions (D. S. Cho, & Lee, J. Y, 2008). However, due to a small number of students with osteopeoporotic and osteopenic *t*-scores, subjects were recategorized into 2 groups for statistical purposes: 'normal BMD' (*t* -score > -1) and 'below normal BMD' (*t* -score $\leq$ -1).

3) Regular exercise

Regular exercise was defined as 3 days a week of moderate intensity exercise (Kelley et al., 2013a, 2013b; Liang et al., 2011). A 'yes,' or 'no' question was included in the survey to determine subjects' involvement in regular exercise. Subjects were also asked to write an estimated overall weekly frequency of exercise (day/week) and time spent (min/week) for outdoor activity. Using Wakayama Medical University's LFQ, past and current weekly exercise hours were also surveyed (Ishimoto et al., 2013). Using LFQ definitions, subjects were categorized into high- and low- frequency exercise groups according to their answers to past and current weekly exercise hours.

Those who exercise more than 5 hours/week were defined as high-frequency group, and those who had less than or equal to 5 hours/week were defined as low-frequency group (Ishimoto et al., 2013).

4) Caffeine consumption

Caffeinated beverage intake was self-reported by using a 'yes' or 'no' question included in the survey (Wetmore et al., 2008). Also, the frequency of daily caffeine intake was included.

5) Dietary intake

Subject's dietary intake was assessed with the use of the food diary and 24-hour recall method (Lim et al., 2008). The subjects kept record of their dietary intake for 3 days including 2 week days and 1 weekend to reflect their average weekly intake (Choi & Kim, 2008; Lim et al., 2008). The 3 day record was written on food diary format that was provided when they signed the consent form. A trained researcher reviewed the food diaries and conducted personal interviews to help the subjects to remember the amount of the food they had consumed by showing them food models and pictures and to specify the ingredients of each dish. All the food consumed for breakfast, lunch, dinner and snacks from rising in the morning till bedtime were surveyed. The types of food materials and the amount of food consumed were also be surveyed. Then, the daily nutrient intakes were analyzed by Computer aided nutrition analysis program (CAN-Pro 3.0; The Korean Nutrition Society, Seoul, Korea). Nutrients that were reported to have an influence on BMD, including those

that are still controversial, were analyzed (Bolton-Smith et al., 2007; Lee, 2013a; Weaver, 2008). Each nutrient examined was compared to the KDRIs, and those that are in <75% of their corresponding KDRIs was defined as a deficient intake ("Management of obesity, 2010 Recommendation," 2010). Also past and current breakfast intakes, milk intakes and other dairy product intakes (defined as dairy products other than milk, e.g. cheese, ice cream, yogurt, cream, yakult, etc.) from elementary school years up to college years, were surveyed using Ishimoto's LFQ (Ishimoto et al., 2013).

6) Nutritional status and body compositions

Subject's nutritional status (BMI) and body compositions (height, weight, body fat mass, skeletal muscle mass, percent body fat, waist-hip ratio and visceral fat area) were measured using InBody720 (Biospace, CA, U.S.A.). InBody 720 has been proven to have a great accuracy with high correlation coefficient of 0.98 with DEXA, the standard equipment for body composition analysis ("InBody720 for research grade analysis ", 2009). The machine uses direct segmental multi-frequency bioelectrical impedance analysis (DSM-BIA) method with 30 impedance measurements by using 6 different frequencies (1^{KHz}, 5^{KHz}, 50^{KHz}, 250^{KHz}, 500^{KHz}, 1000^{KHz}) at each 5 segments (right arm, left arm, trunk, right leg, left leg) ("InBody720 for research grade analysis ", 2009). Nutritional status was determined by BMI result, and the subjects were categorized as underweight (< 18.5), normal (18.5 – 22.9), or overweight (≥23) according to Korean Ministry of Health & Welfare guidelines (*2011 National Health Survey*, 2012). According to their results for percent body fat, waist-

hip ratio and visceral fat area, subjects were divided into categories defined by WHO. Percent body fat was divided into three categories: underfat (<21%), normal (21-33%) and overweight (>33%) (Gallagher et al., 2000). Waist-hip ratio was divided into two categories: normal (<0.85) and abdominal obesity (≥0.85) (Oh et al., 2005). Visceral fat are was divided into two categories: normal (<100cm^2) and increased visceral fat (≥100cm^2).

4. Data collection

This study was conducted for four months (from June to October of 2013) at SNU College of Nursing on female nursing students who fit the inclusion criteria mentioned above and signed the consent forms.

1) Ethical considerations

Prior to data collection, this study was reviewed and approved by Institutional Review Board (IRB) of SNU College of Nursing on June 7th, 2013 (approval number: 2013-37).

2) Study procedure

Study procedure was carried out from June 10th, 2013 to October 25th, 2013 at SNU College of Nursing by the researcher with previous related studies on older women. The study procedure is described in the following order: subject recruitment, subject screening, information meetings, measurements, and completed survey and 3 day food diary collections.

In order to protect human rights during the recruitment, four 30-

minute information sessions were held to explain the purpose of the study, procedures involved in the study, expectations of the subjects, inclusion and exclusion criteria and subjects' choice of voluntary participation and withdrawal from the study. Each information session was held in each grade level students' classrooms and visual PowerPoint presentations and written handouts were given. For those students who have agreed and signed the consent forms, a copy of the consent form was given and another verbal explanation of the purpose and the procedure of Inbody 720, BMD ultrasonometer and survey tools were provided. After the measurements, a verbal explanation of a comprehensive interpretation of Inbody and BMD results were given as well. BMD and Inbody measurements and 3day food diary recollection were carried out at subjects' convenient dates and times. Subjects were asked to write their reachable phone numbers on the surveys. However, prior to survey, subjects were informed about the purpose of collecting phone numbers, method of data keeping, and expected data disposal method. An excess password, which is known only to the researcher, has been created on the server where collected personal data are stored, and all the data are to be disposed upon the completion of the study.

Quality assurance test was performed prior to each BMD measurement, and subjects were measured only if the QUS has passed the quality assurance test. In order to keep consistency of BMD measurement site, all subjects' right calcaneus measurements were evaluated. To avoid any technical errors, each subject's BMD measurement was taken twice and an average of the two t-scores was used for analysis. Seventy percent isopropyl alcohol has been used

as the conductive agent. The GE QUS device used in this study uses fluid-coupled, through-transmission (95mm distance) with quarter wave-matched, broadband single element (25mm diameter) and center frequency of 500 ^{KHz}. A single analysis uses a real-time, fourier transform analysis with bi-directional measurement and convergence algorithms to display stiffness index with WHO graph and WHO-based t-score ("Achilles express: bone ultrasonometer ", 2011).

As for the dietary intakes, written guidelines, formats and sample food diaries were given to the subjects during the information sessions. Also, during these information sessions, plastic food models were shown to the subjects to educate about portion sizes. Subjects were asked to write food diaries in detail, including specific ingredients if possible. Moreover, in order to avoid any dietary fluctuations from subjects' normal patterns, data collection was conducted during the academic semesters to avoid different eating behaviors during subjects' summer break. To avoid fluctuations related to 'back-to-school' parties, data collection was postponed for 2 weeks after the start of fall semester. Also, holidays such as Choo-seok, a Korean thanksgiving day, were avoided to avoid nutritional fluctuations.

Due to DSM-BIA method that is incorporated in the use of InBody 720, subjects were, first, asked if they had any implantable electrical device such as pacemaker, defibrillator, nerve stimulator, or if they were within the first twelve weeks of pregnancy. For data accuracy, subjects were asked to be measured on an empty stomach and bladder, before exercise and to avoid being measured right after a shower or using a sauna as sweat and heat causes

a temporary change in conductivity within the body. Also, subjects were asked to remove their shoes, socks, jewelry and to wear light clothing. Height was measured using an automatic stadiometer (Model BSM370, Biospace height weight scale stadiometer analyzer, Newcastle, NE, USA) prior to the body composition analysis. Then height was inputted accurately into the InBody 720, to prevent any technical errors. During body composition analysis, subjects' were asked to hold handles with bioelectrical devices in each hand and to hold their arms away from the side of the body, not touching the body.

5. Data analysis

Statistical analysis of collected data was performed using SPSS software package (PASW Statistics version 20.0 for Windows, SPSS, Chicago, IL, USA).

1) General characteristics were analyzed using frequency distribution, fraction, mean and standard deviation.

2) Past and current lifestyle patterns were analyzed using frequency distribution and fraction.

3) Dietary intakes were analyzed using CAN-Pro 3.0, and subject's nutrient intake was compared to Korea's daily recommended amount to determine deficiency and excessiveness.

4) Nutritional status and body compositions were analyzed using frequency distribution, fraction, mean and standard deviation.

5) The general characteristics of the subjects, dietary intakes, and nutritional

status and body compositions of the subjects with different BMD status were compared using *t*-test.

6) The past and current lifestyle patterns of the subjects with different *t*-scores were compared using ANOVA.

IV. Results

1. Characteristics of the subjects

1) General characteristics of the subjects

The average age of the subjects was 20.6 (±1.48). The subjects included all grade levels, where sophomore group had the largest number of participants (*n*=50, 31.3%), followed by freshmen (*n*=41, 25.6%), juniors (*n*= 37, 23.1%) and seniors (*n*=32, 20%). In average, students started their menstrual cycle at the age of 12.4. More than half of the students received monthly allowance of more than 401,000 won (*n*=89, 55.6%) and lived in the school dormitory (*n*=85, 53.1%) with roommate(s) (*n*=95, 59.4%). Only 2 subjects (1.3%) identified themselves as current smokers, but 118 (73.8%) and 144 (90%) identified themselves as alcohol and caffeine consumers respectively. One hundred and one (63.1%) students denied of being on a diet, or participating in regular exercises. 123 (76.9%) students used sunscreen to protect their skin, and, on an average, they used sunscreen with SPF level of 32.7 for 4.5 days per week.

None of the subjects had any history of bone health related illnesses, and the majority had no history of medical conditions. However, 17 (10.6%) students had been diagnosed with medical conditions in the past such as atopic dermatitis (*n*=8, 47.1%), allergic rhinitis (*n*=5, 29.4%), polycystic ovary syndrome (*n*=2, 11.8%), hyperlipidemia (*n*=1, 5.85%) and asthma (*n*=1, 5.85%). Twenty five (15.6%) students had a family history of osteoporosis: 16 (64%) with grandmothers with osteoporosis and 9 (36%) with mothers with osteoporosis. Twenty eight (17.5%) students had histories of fracture with a

mean age of 11. Sixteen students (57.1%) experienced bone fracture when they were younger than the group average age 11, and 12 (42.9%) experienced when they were older than 11. Sixteen students fractured their upper extremities, 10 fractured their lower extremities, 1 fractured her hip bone, and 1 fractured her lumbar spine.

The mean *t*-score of all subjects was 0.37 (±1.26), which is within the normal range. However, 20% of the subjects (*n*=32) had *t*-scores that were below the normal range. Among these subjects, 30 (18.8%) were identified as osteopenic, and 2 (1.2%) were identified as osteoporotic. Further analysis have indicated that, among all four grade levels, the number of seniors was the highest within the 'below the normal range' group (*n*=10, 31.3%). (Table 1).

Table 1. General characteristics of the subjects (*N*=160)

Variables		**Mean (±SD)**	***n*(%)**
Age (years)		20.6±1.48	
Grade	Freshman		41 (25.6)
	Sophomore		50 (31.3)
	Junior		37 (23.1)
	Senior		32 (20)
Menarcheal age		12.4±1.14	
Monthly allowance (x10,000 won)	0-20		7 (4.4)
	20.1~40		64 (40)
	>40.1		89 (55.6)
Residence	Parent(s)' house		52 (32.5)
	Dormitory		85 (53.1)
	Own place		23 (14.4)
Cohabitant(s)	With parent(s)		52 (32.5)
	With roommate (s)		95 (59.4)
	Alone		13 (8.1)
Smoking	Yes		2 (1.3)
	No		158 (98.7)
Alcohol consumption	Yes		118 (73.8)
	No		42 (26.2)
Average amount of alcohol consumption per week (glasses)#		4.23 ± 1.32	
Caffeine consumption	Yes		144 (90)
	No		16 (10)
Frequency of caffeine intake/day#		1.69 (±0.95)	
Currently on a diet †	Yes		59 (36.9)
	No		101 (63.1)
Regular exercise	Yes		59 (36.9)
	No		101 (63.1)
Frequency of exercise/wk#		1.25 (±1.58)	
Outdoor activity hrs/wk#		11.6 (±9.17)	
Use of sunscreen	Yes		123 (76.9)

	No		37 (23.1)
Used sunscreen SPF level		32.7 (±16.1)	
Frequency of sunscreen usage/wk		4.53 (±2.71)	
Medical diagnosis	Yes		17 (10.6)
	No		143 (89.4)
Family history of osteoporosis	Yes		25 (15.6)
	No		135 (84.4)
Family member with osteoporosis	Grandmother		16 (64)
	Mother		9 (36)
History of first fracture	Yes		28 (17.5)
	No		132 (82.5)
Age at fracture ††	≤11		16 (57.1)
	>11		12 (42.9)
BMD (*t*-score) †††		0.37(±1.26)	
	Normal		128 (80)
	Osteopenia		30 (18.7)
	Osteoporosis		2 (1.3)

Mean value of the number of subjects who answered 'yes' to the previous variable
† Diet refers to an act of intentional selection or limitation on the amount or type of food intake for reducing weight. Subjects were asked to answer the purpose of their diets in order to exclude those who are on a diet designed or prescribed to improve their physical condition or to prevent or treat a disease. However, all of the 59 students currently on a diet regimen were excluded from this criterion. They were all on a diet for the purpose of achieving slimmer physique.
†† By using the average age of subjects who have experienced fracture (age 11), subjects were divided into two groups.
††† Bone mineral density
*p<.05, **p<.01

2) Past and current lifestyle patterns of the subjects

For analysis of past and current lifestyle habits associated with bone health, subjects were divided into groups based on frequency: high and low. According to LFQ, high frequency was defined for each parameter as the followings: having breakfast (including everyday and 2-3 times/wk), milk intake every day, other dairy product intake every day, and exercise >5 hr in a week (Ishimoto et al., 2013). One hundred and fifty one students (94.4%) consumed breakfast during elementary school, 146 (91.3%) in middle school, 148 (92.5%) in high school and 109 (68.1%) in current days. As for the high frequency milk intake group, 129 (80.6%) in elementary school, 88 (55%) in middle school, 62 (38.8%) in high school and 38 (23.8%) in current days were identified. As for the high frequency other dairy product intake group, 71 (44.4%), 52 (32.5%), 45 (28.1%) and 38 (23.8%) were identified respectively. Last, for the high frequency weekly exercise hour group, 71 (44.4%), 43 (26.9%), 22 (13.8%) and 24 (15%) were identified respectively (Table 2).

Table 2. Past and current lifestyle patterns of the subjects (*N*=160)

Variables			***n*(%)**
Breakfast intake	Elementary school	Consuming	151 (94.4)
		Skipping	9 (5.6)
	Middle school	Consuming	146 (91.3)
		Skipping	14 (8.7)
	High school	Consuming	148 (92.5)
		Skipping	12 (7.5)
	Current	Consuming	109 (68.1)
		Skipping	51 (31.9)
Milk intake	Elementary school	Every day	129 (80.6)
		Less	31 (19.4)
	Middle school	Every day	88 (55)
		Less	72 (45)
	High school	Every day	62 (38.8)
		Less	98 (61.2)
	Current	Every day	38 (23.8)
		Less	122 (76.2)
Other dairy product intake	Elementary school	Every day	71 (44.4)
		Less	89 (55.6)
	Middle school	Every day	52 (32.5)
		Less	105 (67.5)
	High school	Every day	45 (28.1)
		Less	115 (71.9)
	Current	Every day	38 (23.8)
		Less	122 (76.2)
Weekly exercise hours	Elementary school	>5h/wk	71 (44.4)
		≤5h/wk	89 (55.6)
	Middle school	>5h/wk	43 (26.9)
		≤5h/wk	117 (73.1)
	High school	>5h/wk	22 (13.8)
		≤5h/wk	138 (86.2)
	Current	>5h/wk	24 (15)
		≤5h/wk	136 (75)

3) Dietary intakes of the subjects

According to the analysis of subjects' 3d food diaries via Can-Pro, some of the nutrients were notable in which more than half of the subjects had either deficient or excessive intakes. In this study, only those that are bone-health-related and health-behavior-related nutrients were focused in this study. The nutrients that had more than 50% of the subjects with deficiency were vitamin D, biotin, calcium, chlorine, potassium, magnesium and iodine. Those that had more than 50% of the subjects with excessive intakes were sodium, fluorine and cholesterol (Table 3).

Table 3. Dietary intakes of the subjects (*N*=160)

Variables		**Mean (±SD)**	***n* (%)**
Total energy (Kcal/day)†		1985.1 (±437.5)	
Carbohydrate (g/day)†		272.2 (±57.5)	
Fat (g/day)†		65.3 (±20.3)	
Protein (g/day)	Deficient (<75% KDRI)		1 (0.6)
	Adequate		159 (99.4)
Fiber (g/day)	Deficient		51(31.9)
	Adequate		109 (68.1)
Vitamin D (μg/day)	Deficient		104 (65.0)*
	Adequate		56 (35.0)
Vitamin K (μg/day)	Deficient		3 (1.9)
	Adequate		157 (98.1)
Vitamin C (mg/day)	Deficient		79 (49.4)
	Adequate		81 (50.6)*
Biotin (μg/day)	Deficient		130 (81.3)*
	Adequate		18.5 (18.8)
Calcium (mg/day)	Deficient		84 (52.5)*
	Adequate		76 (47.5)
Phosphorus (mg/day)	Deficient		1 (0.6)
	Adequate		159 (99.4)
Sodium (mg/day)	Adequate		23 (14.4)
	Excessive		137 (85.6)*
Chlorine (g/day)	Deficient		156 (97.5)*
	Adequate		4 (2.5)
Potassium (g/day)	Deficient		101 (63.1)*
	Adequate		59 (36.9)
Magnesium (mg/day)	Deficient		159 (99.4)*
	Adequate		1 (0.6)
Zinc (mg/day)	Deficient		11 (6.9)
	Adequate		149 (93.1)
Copper (μg/day)	Deficient		12 (7.5)
	Adequate		148 (92.5)
Fluorine (mg/day)	Deficient		12 (7.5)
	Adequate		23 (14.4)
	Excessive		125 (78.1)*
Manganese (mg/day)	Deficient		60 (37.5)

	Adequate	98 (61.3)
	Excessive	2 (1.3)
Iodine (μg/day)	Deficient	87 (54.4)*
	Adequate	73 (45.6)
Cholesterol (mg/day)	Adequate	74 (46.3)
	Excessive	86 (53.8)*

† Because recommended total energy, carbohydrate and fat intakes depend on the subject's body composition, and because the ratio rather than the amount of the intakes of these dietary components is more emphasized, the mean values (±standard deviation) were analyzed (*2011 5th National Health & Nutrition Survey*, 2011).

*$n \geq 50\%$ of total subjects

4) Nutritional status and body compositions of the subjects

Nutritional status based on BMI showed that 115 subjects (71.9%) were within the normal range, but 45 subjects (28.1%) deviated with 11 (6.9%) being underweight and 34 (21.3%) being overweight. The average weight and height of the subjects were 55.2 (±5.68) and 161 (±4.02) respectively. The average body fat mass and skeletal muscle mass were 16.9(±3.71) and 20.5(±1.77). The average percent body fat was 30.1(±4.18). Subjects were categorized into 3 groups according to their percent body fat with WHO definitions. One hundred and twelve students (70%) were within the normal range, but 4 (2.5%) were identified as having underfat and 44 (27.5%) were identified as overweight with too much percent body fat. Waist-hip ratio was categorized into normal (*n*=135, 84.4%) and abdominal obesity (*n*=25, 15.6%). Visceral fat area was also categorized into 2 groups: normal (*n*=157, 98.1%) and increased visceral fat (*n*=3, 1.9%) (Table 4).

Table 4. Nutritional status and body composition of the subjects (*N*=160)

Variables		**Mean (±SD)**	***n* (%)**
Nutritional status†		21.31(±1.97)	
	Normal		115 (71.8)
	Underweight		11 (6.9)
	Overweight		34 (21.3)
Weight (kg)		55.2(±5.68)	
Height (cm)		161.0(±4.02)	
Body fat mass (kg)		16.9(±3.71)	
Skeletal muscle mass (kg)		20.5(±1.77)	
Percent body fat (%)		30.1(±4.18)	
	Normal		112 (70)
	Underfat		4 (2.5)
	Overweight		44 (27.5)
Waist-hip ratio		0.81(±0.03)	
	Normal		135 (84.4)
	Abdominal obesity		25 (15.6)
Visceral fat area (cm^2)		38.6(±12.3)	
	Normal		157 (98.1)
	Increased visceral fat		3 (1.9)

† Defined by Body mass index (BMI) (kg/m^2)

2. Comparative and correlational statistics of observed variables with BMD

1) Comparison of general characteristics between subjects with different BMD groups

Among identified general characteristics, there was a mean difference in *t*-scores between the 'normal' and 'below normal' groups for daily frequency of caffeine intake (p=.07) and weekly frequency of exercise (p=.05) with a marginal significance (Table 5).

Table 5. General characteristics of the subjects with different *t*-score status (N=160)

Variables	**Mean(±SD)**	**Normal BMD: *t*-score >-1.0 (*n* =128, 80%)**	**Below normal BMD: *t*-score ≤ -1.0 (*n* =32, 20%)**	***p*†**
Frequency of caffeine intake/day	1.69(±0.95)	1.59 (±1.10)	2.05 (±1.82)	.07
Frequency of exercise/wk	1.25(±1.58)	1.37 (±1.98)	0.78 (±1.39)	.05

†Significance among groups was determined by *t*-test; *, p<0.05

2) Comparison of past and current lifestyle patterns between subjects with different BMD groups

Due to different distribution of 'normal' and 'below normal' students within high- and low- frequency groups for past and current lifestyle patterns, only *t*-score comparison between frequency groups were analyzed. Table 6 compares *t*-scores between high- and low-frequency groups for each parameter during elementary school, middle school, high school and the current days. *t*-score was significantly associated with current high milk intake frequency (vs. less than every day, p=0.02). Current breakfast intake (vs. skipping, p=.07), high milk intake frequency during high school (vs. less than every day, p=.05) and longer exercise duration during elementary (vs. less than 5hr/wk, p=.07) had a tendency of having associations with *t*-score (Table 6).

Table 6. Past and current lifestyle patterns of the subjects and their relation to *t*-score (*N*=160)

Variables			**Mean(±SD)**	***p*†**
Breakfast intake	Current	Consuming	.53(±1.66)	
		Skipping	.03(±1.41)	.07
Milk intake	High school	Every day	.68(±1.64)	
		Less	.17(±1.55)	.05
	Current	Every day	.89(±1.65)	
		Less	.20(±1.55)	.02
Weekly exercise hours	Elementary school	>5h/wk	.63(±1.52)	
		≤5h/wk	.16(±1.63)	.07

† Significance among groups was determined by *t*-test; *, p<0.05

3) Comparison of dietary intakes of the subjects with different BMD groups

Among analyzed nutrients, only copper had a significant difference between the normal BMD and below normal BMD groups. The students who had normal *t*-scores had a significantly higher intake of copper (p=0.03), and higher intake of vitamin B5 (p=0.07) with a marginal significance (Table 7).

Table 7. Dietary intakes of the subjects with different *t*-score status (N=160)

Variables	**Mean(±SD)**	**Normal BMD: *t*-score >-1.0 (*n* =128, 80%)**	**Below normal BMD: *t*-score ≤ -1.0 (*n* =32, 20%)**	***p*†**
Vitamin B5	4.06(±1.57)	4.19 (±1.90)	3.50 (±1.86)	0.07
Copper	1.09(±0.28)	1.12 (±0.37)	0.98 (±0.30)	0.03*

† Significance among groups was determined by *t*-test;
*, p<0.05

4) Comparison of nutritional status and body composition of the subjects with different BMD groups

There were significant differences in height (p=.03). We also found a mean difference in BMI (p=.06) with a marginal significance between the two groups. Subjects with normal t-scores were significantly shorter than those in with below normal t-scores (p=.03), and had a tendency to have higher BMI (p=.06) (Table 8).

Table 8. Nutritional status and body composition of the subjects with different *t*-score status (N=160)

Variables	**Mean(±SD)**	**Normal BMD: *t*-score >-1.0 (*n* =128, 80%)**	**Below normal BMD: *t*-score ≤ -1.0 (*n* =32, 20%)**	***p*†**
BMI (kg/m^2) ††	21.3(±1.97)	21.5 (±2.70)	20.5 (±2.02)	.06
Height (cm)	161.0(±4.02)	160.5 (4.73)	162.7 (±6.45)	.03*
Weight (kg)	55.3(±5.68	55.5 (±7.70)	54.5 (±6.88)	.51
Skeletal muscle mass (kg)	20.5(±1.77)	20.6 (±2.32)	20.4 (±2.32)	.65
Body fat mass (kg)	16.9(±3.71)	17.1 (±4.99)	16.2 (±4.35)	.33
Percent body fat (%)	30.2(±4.18)	30.3 (±5.23)`	29.6 (±5.57)	.50
Waist-hip ratio	0.81(±0.03)	0.81 (±0.04)	0.80 (±0.37)	.31
Visceral fat area (cm^2)	38.6(±12.3)	38.7 (±18.3)	38.1 (±14.8)	.86

† Significance among groups was determined by *t*-test; †† Body mass index; *, p<0.05

V. Discussion

Our study has investigated the lifestyle patterns, dietary intakes, nutritional status, and body compositions of female college students at a nursing school in Seoul, Korea and the effects of those parameters on BMD.

In this study of young Korean female college students, we found that out subjects had a high ratio of caffeine consuming students (90%) (Conlisk & Galuska, 2000; Wetmore, Ichikawa, LaCroix, Ott, & Scholes, 2008). Our study showed much higher than that of previous Japanese studies 23.1% and 67.6% respectively) (Furukawa et al., 2013; Shimamoto et al., 2013). However, our result was similar to that of previous Korean female college student studies including both general education majors and nursing majors, where close to or more than 80% of the subjects were caffeine consumers (Chon, Jeon, & Kim, 2012; J. Y. Kim, 2010). On an average, our subjects consumed about 2 cups (about 400ml) of caffeine on a daily basis, which is considered as a high consumption of caffeine according to previous studies (Hallstrom et al., 2013; J. Kim, 2010). Further analysis has found that the ratio of students who had high caffeine consumption was much higher in our students (41.9%) than previous studies on Western students (33.6%) and Korean students (29.7%) (Hallstrom et al., 2013; J. Kim, 2010). Congruent with previous studies, our study has also found that more frequent caffeine intake per day had a negative effect on *t*-score (Harter et al., 2013; Wetmore et al., 2008). Students with below the normal BMD consumed more than 2 cups of caffeine per day. Our hypothesis is that these results may have stemmed from an increased number of coffee shops in Korea within the last decade (J. Kim, 2010; Park & Oh, 2013).

We found that our results on the past and current lifestyle patterns related to breakfast was partly consistent with Korean national and previous study data ("Health Insurance Review & Assessment Service," 2012). Although our subjects consumed breakfast in the past, currently, 31.9% of our subjects identified themselves as breakfast skippers. This was similar to that of the national data, which has identified the age group 19-29 as the largest group that skips breakfast (*2011 5th National Health & Nutrition Survey*, 2011). Our data has shown a tendency of mean *t*-score difference between the current breakfast consuming students and breakfast skipping students (p=.07). However, the portion of our subjects who currently skip breakfast was more than three times larger than that of a previous Japanese study (11.5%) (Ishimoto et al., 2013). This discrepancy may be explained through the living places of the subjects. Most of our subjects lived away from their parents' house (67.5%), which put the subjects responsible for preparing for their own breakfast. Previous study that compared Korean and Japanese female colleges students' lifestyle patterns also showed that much larger portion of Korean students skipped breakfast compared to Japanese students, and that bigger number of Korean students were living apart from their parents compared to Japanese students who mostly lived at home (Kim & Sawano, 2010). Although our study did not include the reason behind breakfast skipping behavior, previous studies have identified that students tend to skip breakfast due to time constraint (Choi, Shin, Huh, & Chung, 2009; Chung et al., 2010; Kim & Sawano, 2010). Our hypothesis was supported by further analysis. Compared to freshmen and sophomores (28.1%), who mostly live at home and commute to school, larger percentage of juniors and seniors (36.6%), who are

recommended to live in the dormitory due to clinical practicum schedules, were identified as breakfast skippers.

Surprisingly, we found that a large portion of subjects had excessive intakes of sodium and cholesterol. The average sodium intake was about 3 times greater than the KDRI of 1.5g, and 85.6% of the subjects were identified to have excessive sodium intakes. Also, more than half of our subjects (53.8%) displayed excessive intake of cholesterol in their diet. Surprisingly, the subjects' sodium intake and cholesterol intake were much larger than that of previous Korean studies but similar to that of a western study (J. H. Choi & Kim, 2008; Lim et al., 2008; Larson et al., 2009). These results may be linked to the current Korean college students' westernized diets, which usually contain high amount of sodium and cholesterol. Our hypothesis was supported by further analysis of students' dietary intakes. When students consumed western foods such as pasta, pizza, burgers, sandwiches and friend foods, the sodium and cholesterol intakes increased compared to when they consumed traditional Korean foods. Also, the sodium and cholesterol's contribution ratio from these food items took up the majority of the daily sodium (63.1%) and cholesterol (72%) intakes of the subjects. Also, further analysis of 3 day food diaries have indicated that the majority of high-sodium and high-cholesterol food intakes tended to be from late-night snacks. Students, especially those who lived in the dormitory, tended to consume fast foods and delivery foods that contained excessive sodium and cholesterol, such as ramen noodles, fried chicken, Chinese foods and pizza for late-night snacks. Juniors and seniors (70.6%), who mostly live in the dormitory had higher portion of subjects with excessive cholesterol intake compared to freshmen and sophomores (56.1%)

Similar to previous studies, unhealthy dietary habits were identified in our subjects who were involved in dormitory life (Yaguchi-Tanaka, Kawagoshi, Sasaki, & Fukao, 2013).

Although a relatively large number of subjects were found to have excessive sodium and cholesterol intakes, reflecting an undesirable health behavior, a high ratio of our subject had adequate fiber and vitamin C intakes compared to previous studies on western and Korean students (Byrd-Williams, Strother, Kelly, & Huang, 2009; Cho, 2008; Kumar, Mittal, Orito, Ishitani, & Ohta, 2010). Further investigation of these dietary intakes has shown different ratio of students with adequate intakes according to the grade levels. The lower (freshmen and sophomores) classmen had significantly higher mean fiber intake (p=.01) and vitamin C intake (p<.01) than the upper classmen (juniors and senior). Although the fiber intakes in each grade was similar to another, a decreasing trend was noted in adequate vitamin C consumers as the grade level got higher (freshmen: 68.3%; sophomores: 60.4%; sophomores: 35.9%; seniors: 25%). Further statistical analysis has shown that freshmen's average vitamin C intake was significantly higher than juniors' (p<.01) and seniors' (p=.01), and sophomores' was significantly higher than juniors' (p=.05). These results may have been related to the residential area of the students, similar to a previous study (Nelson & Story, 2009). The amount of vitamin C intake decreased as the students lived apart from their family and head house, possibly indicating a general lack of fruit consumption when female college students became responsible for their own dietary intakes.

We found that, in relation to bone health, a relatively large portion of our subjects had deficiencies in calcium and vitamin D. Compared to female

college students abroad, our subjects' calcium intake was much lower, which was consistent with studies that reported low calcium intake in Korean females (Cho, 2008; C. Kim & Kim, 2010; Larson et al., 2009). This difference in intake levels may be closely related to the differences in food cultures and comparatively lower intake of milk and dairy products in Korean population than the western countries (C. Kim & E. Kim, 2010). Although our study was similar to that of previous studies on Korean female students in which more than half of the subjects were deficient in calcium, the average calcium intake was slightly higher in our subjects (Hong et al., 2012; Lim et al., 2008). However, the difference may have been from the study methods. The food frequency questionnaires in Hong's and a low number of subject in Lim's study (n=38) were indicated, therefore, our results may portray more accurate and provide better understanding of calcium intake among female college students. Further analysis of our data has noted that about half of each grade had calcium deficiency: 53.7% in freshmen, 54.2% in sophomores, 51.3% in juniors and 50% in seniors. The portion of subjects who had vitamin D deficiency in our study was congruent with some of the previous studies conducted in western countries and Korea (Burke, Reilly, Morrell, & Lofgren, 2009; Hall et al., 2010; Lee, 2013). Previous study has shown that vitamin D deficiency is closely related to calcium deficiency especially in young women due to the tendency of calcium-rich foods being rich in vitamin D as well (Raiten & Picciano, 2004). Further analysis of our data has shown a congruent result, where 72.6% of calcium deficient subjects also showed deficiency in vitamin D intake. Significant average t-score differences were noted among daily milk consumers and non-daily consumers during high school and current

days. However, for the milk and other dairy product intakes, our subjects showed similar patterns with the national data and the Japanese data, where more than 70% of the subjects were not engaged in daily consumption. This may be explained by a considerably low intake of dairy products among Asian cultures compared to other western and European cultures (Wetmore, Ichikawa, LaCroix, Ott, & Scholes, 2008).

The nutritional status and body compositions of our subjects were comparable to that of previous western and Korean studies. Although the average nutritional status of the subjects (BMI) was similar to previous studies, differences were noted in the specific body compositions. Compared to a western study, our subjects had lower weight, body fat mass, skeletal muscle mass and percent body fat (Nieves et al., 2010). This may be closely linked to lower portion of subjects involvement in exercise that the western country. Compared to a previous Korean study, our subjects had heavier weight, body fat mass, skeletal muscle mass and percent body fat (Hong et al., 2012). This difference may also have been related to subjects' involvement in regular exercise. Although a large number of our students were not involved in regular exercise, Hong's subjects may have had even larger number of students lacking exercise.

We found a general lack of exercise among the subjects. Previous studies reported that about 20 minutes of modest impact activity or resistance training three times a week can improve bone mineral density (Kai, Anderson, & Lau, 2003; Price, Langford, & Liporace, 2012). However, our study showed only 36.9% of subjects to be engaged in regular exercise which was much lower than those reported in previous studies on female college students in

western countries (Elgan, Dykes, & Samsioe, 2002; Marwaha et al., 2011). Also, our subjects had less weekly hours spent on outdoor activities than that of western studies (Nieves et al., 2010; Marwaha et al., 2011). This difference between Korean and western students was similar to that of previous Korean studies, indicating a lack of exercise among Korean females (Kang, 2009; Lee, Lee, & Kim, 2011). Furthermore, our subjects showed much greater lack of exercise than previous Korean studies. Our study has shown that among non-regular exercisers, 90 (89.1%) students were not participating in any exercise at all on a weekly basis. This was much higher than that of previous Korean study (76%) (Lee, Lee, & Kim, 2011). Also, the average weekly frequency of exercise was lower in our subjects compared to previous Korean studies (2.25±0.58; 2.15±1.02) (Chon, Jeon, & Kim, 2012; Lee, Lee, & Kim, 2011). This may be partly due to our students' engagement in clinical practicums as they advance within the nursing school curriculum which cause a lack of time for exercise. Our hypothesis was supported by further analysis. We found that there was a tendency of a decrease in the weekly frequency of exercise as the grade level increased, which was congruent with some of the previous studies (Buckworth & Nigg, 2004; Egli, Bland, Melton, & Czech, 2011). Freshmen were engaged in more frequent exercise (p=.06) and spent more hours on outdoor activities (p=.01) than sophomores, and they also spent more hours on outdoor activities (p=.03) than juniors. A further investigation was conducted on students in relation to an involvement in regular exercise. Although there was no significant difference in BMD between the students who are involved in regular exercise and those who are not, some differences were noted in lifestyle patterns, body composition and dietary intakes between the two

groups. Regularly exercising students tended to have less daily caffeine intakes (p=.06), spend more time on weekly outdoor activities (p=.07), had significantly more frequent weekly exercise (p<.00), tended to weigh more (p=.08), had significantly more skeletal muscle mass (p=.01), and tended to have higher intakes of vitamin C (p=.09) and zinc (p=.08). Although regular exercise was not a significant determinant factor that is directly related to BMD in our subjects, it was interesting to find that an involvement in regular exercise was found to be positively correlated with other factors that are reported to strengthen BMD.

We found that the average *t*-score of our subjects was slightly higher that some of the reported values in previous studies in Korea that used the same BMD measuring methods (J.H. Choi & Kim, 2008; C. Kim & E. M. Kim, 2010). This discrepancy may have resulted from considerably favorable body composition and nutritional intakes of our subjects. Our subjects had heavier weight, body fat mass, skeletal muscle mass, percent body fat and BMI than that of previous studies'. Also, the average intakes of total energy (Kcal), protein and calcium were much higher in our subjects. However, due to our study limitation of having such a small portion of students with osteopenic and osteoporotic *t*-scores, very few variables were noted to have significant relationship with BMD.

Because our study was limited to students attending to one college and majoring in a specific study, it is hard to generalize the results to all of the Korean female college students. However, it should be noted that this study included all grade levels of students. Also, given that all subjects were majoring in nursing and, therefore, had more exposure to health information, it

is interesting that the subjects had low compliance to health-promoting lifestyle behaviors.

VI. Conclusion

This study was a cross-sectional study conducted to investigate the effect past and current lifestyle patterns, dietary intake, nutritional status and body composition on Korean female college students' BMDs.

The study was conducted from June, 2013 to October, 2013 on 160 female college students enrolled in SNU College of Nursing. The summary of the study results are as of the following:

1) 90% of the Korean female college students were engaged in caffeine consumption
2) 63.1% of the Korean female college students were not involved in regular exercise.
3) Breakfast and milk consumptions have a positive effect on increasing BMD.
4) Lifestyle patterns including milk consuming behavior and exercising during elementary school and high school positively affect BMD in college years.
5) Korean female college students tend to have unfavorable dietary intake habits with low vitamin D, vitamin C, biotin, calcium, chlorine, potassium, magnesium and iodine intakes and high sodium, fluorine and cholesterol intakes.
6) BMI, weight, skeletal muscle mass, body fat mass and percent body fat have a positive effect on increasing BMD.

From these study results, suggestions for future research are as of the followings:

1) Longitudinal studies that investigate bone-related lifestyle patterns starting from childhood up to early adulthood should be established.
2) Studies that promote regular exercise female college students should be established.
3) Studies investigating specific reasons for bone-promoting nutrient deficiency in Korean female college students and promoting intakes should be established.

VII. Reference

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VIII. Appendix 1

설문지

안녕하십니까?

본 설문지는
‘한국 여대생의 영양상태, 식이 섭취 및 생활 습관이 골밀도에 미치는 영향’ 의 연구용으로 사용하기 위한 자료입니다.

이 연구의 조사내용은 오직 연구 목적으로만 사용되며
자세히 기록하여 주시면 감사하겠습니다.

바쁘신 가운데 번거롭게 해드려 대단히 죄송하오며,
협조해 주셔서 감사합니다.

ID	
이름	
날짜	
연락처	

1. 연구 참여 동의서– [참여자 보관용]

연구 제목: The effects of nutritional status, dietary intake and lifestyle habits on bone mineral density in Korean female college students

본 연구는 서울시내에 있는 간호대학교에서 총 120명의 대학생을 대상으로 골밀도에 영향을 미치는 관련인자들과 골밀도와의 상관관계를 분석해 보기 위한 연구입니다. 본 연구는 자발적으로 참여 의사를 밝히신 분에 한하여 수행될 것이고 연구에 참여하신 후에도 언제든지 그만두실 수 있습니다.

연구에 참여하시게 되면 신장, InBody측정, 골밀도 측정 및 설문 조사를 하시게 됩니다. **위의 조사를 받기 전 주 3일 동안 (주중 2일, 주말 1일) 식이일지 (food diary)를 작성해 오시면 됩니다. 작성하신 식이일지는 설문조사 시 확인을 해드릴 예정입니다.** 검사와 설문 조사를 하시는데 소요되는 시간은 한 시간 정도가 걸릴 예정이고 본 연구에 시간을 내어 참여해주신 답례로 참여자분의 현재 건강상태를 파악할 수 있으며 추후 골밀도 증진, 유지 및 골다공증 예방을 위한 자료가 될 수 있는 Inbody와 골밀도 측정 결과와 영양소별 섭취상태를 교육 받으시게 되며 소정의 선물을 제공하여 드립니다.

연구에 참여해주시는 대상자분의 신상에 관한 정보는 이름과 전화번호로 제한되며, 수집된 모든 정보는 연구책임자 1인과 연구 보조원 1인만이 알 수 있도록 처리하여 잠금 장치가 있는 곳에 보관하고 연구 논문이 인쇄자료로 발표된 후에는 분쇄 폐기 처리될 것입니다.

연구에 참여하여 주셔서 감사합니다.

"본인은 이 연구에 대한 설명을 충분히 들었으며, 이 연구에 참여할 것을 동의합니다. 본인은 자발적으로 이 연구에 참여하고 있음을 알고 있습니다."

성명:_____(서명)　　날짜:___/___/___

이 연구는 서울대학교 간호대학 연구대상자 보호 심사 위원회의 승인을 받았습니다.

- 연구 책임자: 서울대학교 간호대학 **박다인**
- 연구 책임자 연락처: 02-740-8454

2. 연구 참여 동의서– [연구자 보관용]

연구 제목: The effects of nutritional status, dietary intake and lifestyle habits on bone mineral density in Korean female college students

본 연구는 서울시내에 있는 간호대학교에서 총 120명의 대학생을 대상으로 골밀도에 영향을 미치는 관련인자들과 골밀도와의 상관관계를 분석해 보기 위한 연구입니다. 본 연구는 자발적으로 참여 의사를 밝히신 분에 한하여 수행될 것이고 연구에 참여하신 후에도 언제든지 그만두실 수 있습니다.

연구에 참여하시게 되면 신장, InBody측정, 골밀도 측정 및 설문 조사를 하시게 됩니다. **위의 조사를 받기 전 주 3일 동안 (주중 2일, 주말 1일) 식이일지 (food diary)를 작성해 오시면 됩니다. 작성하신 식이일지는 설문조사 시 확인을 해드릴 예정입니다.** 검사와 설문 조사를 하시는데 소요되는 시간은 한 시간 정도가 걸릴 예정이고 본 연구에 시간을 내어 참여해주신 답례로 참여자분의 현재 건강상태를 파악할 수 있으며 추후 골밀도 증진, 유지 및 골다공증 예방을 위한 자료가 될 수 있는 Inbody와 골밀도 측정 결과와 영양소별 섭취상태를 교육 받으시게 되며 소정의 선물을 제공하여 드립니다.

연구에 참여해주시는 대상자분의 신상에 관한 정보는 이름과 전화번호로 제한되며, 수집된 모든 정보는 연구책임자 1인과 연구 보조원 1인만이 알 수 있도록 처리하여 잠금 장치가 있는 곳에 보관하고 연구 논문이 인쇄자료로 발표된 후에는 분쇄 폐기 처리될 것입니다.

연구에 참여하여 주셔서 감사합니다.

"본인은 이 연구에 대한 설명을 충분히 들었으며, 이 연구에 참여할 것을 동의합니다. 본인은 자발적으로 이 연구에 참여하고 있음을 알고 있습니다."

성명:_____(서명)　　날짜:___/___/___

이 연구는 서울대학교 간호대학 연구대상자 보호 심사 위원회의 승인을 받았습니다.

- 연구 책임자: 서울대학교 간호대학 **박다인**
- 연구 책임자 연락처: 02-740-8454

I. 신체계측

1. 키: _____cm

2. 체중:_____kg

3. BMI _____kg/m^2

4. Body fat mass _____kg

5. Skeletal muscle mass _____kg

6. Body fat percentage _____%

	①		②	
7. 골밀도	측정부위	Rt / Lt	측정부위	Rt / Lt
	Stiffness Index		Stiffness Index	
	T-score		T-score	
	Z-score		Z-score	

II. 일반적 사항

1. 나이	만 _____세
2. 성별 (동그라미 치세요)	(여자) (남자)
3. 현재 학년	대학교_____학년
4. (2번이 여자일 경우) 초경연령	만 _____세
5. 월 용돈 (한달 동안 지출액)	□ 0 ~ 10 만원 □ 11 ~ 20 만원 □ 21 ~ 30 만원 □ 31 ~ 40 만원 □ 41 ~ 50 만원 □ 51 만원 이상
6. 현재 거주 공간	□ 집 (본가) □ 기숙사 □ 자취 □ 친척집 □ 그 외:
7. 동거인	□ 부모님 포함한 가족 □ 형제, 자매, 남매끼리 □ 룸메이트 □ 혼자

III. 건강상태

1. 본인이 의사에게 진단받은 질환 (전신 질환)	
2. 본인의 뼈 질환 진단 여부	(유) (무)
3. (2번이 '유' 인 경우) 의사에게 진단받은 질병명	
4. 골다공증 가족력 (동그라미 치세요)	(유) (무)
5. (4번이 '유' 일 경우) 가족 중 현재 골다공증을 앓고 있는 사람은?	
6. 골절 경험	(유) (무)
7. (6번이 '유' 일 경우) 골절 경험 나이	만 _____세
8. (6번이 '유' 일 경우) 골절 부위	
9. 현재 흡연 여부	(예) (아니오)
10. (9번이 '예' 일 경우) 하루 흡연 담배 양과 지금까지 흡연 기간	하루 담배_____개피 지난_____ 달/년 동안
11. 과거 흡연 여부	(예) (아니오)
12. (11번이 '예' 일 경우) 과거 흡연 시 담배 양과 과거 흡연 기간	하루 담배_____개피 _____달/년 동안

13. 음주 여부	(예) (아니오)
14. (13번이 '예 일 경우) 일주일 간 음주 빈도, 종류와 양	일주일 _____ 회/주 종류 □ 소주 □ 맥주 □ 막걸리 □ 포도주 □ 양주 □ 기타 양 (1회 음주 시 섭취량) □ 1잔 □ 2잔 □ 3잔 □ 4잔 □ 5잔이상
15. 카페인 섭취 여부 (커피, 차, 핫식스, 탄산음료 포함)	(예) (아니오)
16. (15번이 '예' 일 경우) 섭취 카페인 종류	
17. (15번이 '예' 일 경우) 섭취 카페인 종류별 하루 섭취 양과 빈도	종류 하루 _____잔 하루 _____회 종류 하루 _____잔 하루 _____회 종류 하루 _____잔 하루 _____회 종류 하루 _____잔 하루 _____회 종류 하루 _____잔 하루 _____회
18. 현재 다이어트 여부	(예) (아니오)
19. (18번이 '예' 일 경우) 다이어트의 목적	(1) 체중 감소 (미적 이유) (2) 특정 질환 때문에
20. 현재 규칙적인 운동 여부	(예) (아니오)

21. (20번이 '예' 일 경우) 운동의 종류와 빈도	□ 경도의 운동 (산책, 골프 등) – 운동횟수_____회/week – 1회 평균 운동 시간_____분 □ 중증도의 운동 (조깅, 자전거 등) – 운동횟수_____회/week – 1회 평균 운동 시간_____분 □ 격렬한 운동 (빠르게 달리기, 스피닝, 필라테스 등) – 운동횟수_____회/week – 1회 평균 운동 시간_____분
22. 현재 복용하는 약물 여부 (여자일 경우, 피임약 복용도 포함)	(예) (아니오) 약물 이름 및 용도:
23. 과거 정기적으로 처방 받고 복용한 약물 (예: 성장호르몬 주사)	(예) (아니오) 약물 이름 및 용도:
24. 선크림 사용 여부	(예) (아니오)
25. (23번이 '예' 일 경우) 사용 선크림의 SPF 지수와 사용횟수	_____SPF _____회/week
26. 한 주 당 평균 야외 활동 시간	주 _____시간

IV. 과거 식이 및 운동

1. 아침식사 여부	1) 초등학교: □ ① 매일------ 주 7회 아침식사 □ ② 가끔------주 2-3회 아침식사 □ ③ 안 함------ 주 0회 아침식사
	2) 중학교: □ ① 매일------- 주 7회 아침식사 □ ② 가끔------ 주 2-3회 아침식사 □ ③ 안 함------ 주 0회 아침식사
	3) 고등학교: □ ① 매일------- 주 7회 아침식사 □ ② 가끔------ 주 2-3회 아침식사 □ ③ 안 함------ 주 0회 아침식사
	4) 현재: □ ① 매일------- 주 7회 아침식사 □ ② 가끔------ 주 2-3회 아침식사 □ ③ 안 함------ 주 0회 아침식사
2. 우유 섭취 여부	1) 초등학교: □ ① 매 끼니-- 주 14-21회 우유 섭취 □ ② 매일------ 주 7회 우유 섭취 □ ③ 매 주--- -주 1회 우유 섭취 □ ④ 주 1회 이하 우유 섭취
	2) 중학교: □ ① 매 끼니-- 주 14-21회 우유 섭취 □ ② 매일------ 주 7회 우유 섭취 □ ③ 매 주--- -주 1회 우유 섭취 □ ④ 주 1회 이하 우유 섭취
	3) 고등학교: □ ① 매 끼니-- 주 14-21회 우유 섭취 □ ② 매일------ 주 7회 우유 섭취 □ ③ 매 주--- -주 1회 우유 섭취 ④ 주 1회 이하 우유 섭취

	4) 현재: □ ① 매 끼니-- 주 14-21회 우유 섭취 □ ② 매일------ 주 7회 우유 섭취 □ ③ 매 주--- -주 1회 우유 섭취 □ ④ 주 1회 이하 우유 섭취
3. 우유 외 유제품 섭취 여부 (치즈, 요구르트, 요플레, 생크림, 버터 등)	1) 초등학교: □ ① 매 끼니-주 14-21회유제품 섭취 □ ② 매일---- 주 7회 유제품 섭취 □ ③ 매 주---- 주 1회 유제품 섭취 □ ④ 주 1회 이하 유제품 섭취
	2) 중학교: □ ① 매 끼니-주 14-21회유제품 섭취 □ ② 매일---- 주 7회 유제품 섭취 □ ③ 매 주---- 주 1회 유제품 섭취 □ ④ 주 1회 이하 유제품 섭취
	3) 고등학교: □ ① 매 끼니-주 14-21회유제품 섭취 □ ② 매일---- 주 7회 유제품 섭취 □ ③ 매 주---- 주 1회 유제품 섭취 □ ④ 주 1회 이하 유제품 섭취
	4) 현재: □ ① 매 끼니-주 14-21회유제품 섭취 □ ② 매일---- 주 7회 유제품 섭취 □ ③ 매 주---- 주 1회 유제품 섭취 □ ④ 주 1회 이하 유제품 섭취
3. 운동 여부	1) 초등학교: □ ① 주 ≥10시간 이상 운동 □ ② 주 5-10 시간 운동 □ ③ 주 2-5시간 운동 □ ④ 주 1-2시간 운동 □ ⑤ 주 <1시간 이하 운동
	2) 중학교: □ ① 주 ≥10시간 이상 운동 □ ② 주 5-10 시간 운동 □ ③ 주 2-5시간 운동 □ ④ 주 1-2시간 운동 □ ⑤ 주 <1시간 이하 운동

	3) 고등학교: □ ① 주 ≥10시간 이상 운동 □ ② 주 5-10 시간 운동 □ ③ 주 2-5시간 운동 □ ④ 주 1-2시간 운동 □ ⑤ 주 <1시간 이하 운동
	4) 현재: □ ① 주 ≥10시간 이상 운동 □ ② 주 5-10 시간 운동 □ ③ 주 2-5시간 운동 □ ④ 주 1-2시간 운동 □ ⑤ 주 <1시간 이하 운동

IX. Appendix 2

Food diary　　주 조리자 □ ① 본인 □ ② 배우자 □ ③ 자녀 □ ④ 기타

식사기록의 예				1 일째 (날짜:_____월_____일_____요일)	
		음식 이름(재료 이름)	먹은 양	음식 이름(재료 이름)	먹은 양
아 침	밥	쌀 밥	1 공기		
	국/찌개	미 역 국	1 대접		
	반찬	시금치 나물 꽁 치 구 이 김 구 이	5 젓가락 1 토막 5 장		
	김치	배 추 김 치	1 접시		
	간식	커피	1 컵		
점 심	밥	보 리 밥	1/2 공기		
	국/찌개	김 치 찌 개	1/2 대접		
	반찬	고등어 조림 멸 치 볶 음	1/2 토막 3 젓가락		
	김치	깍두기	5 개		
	간식	사 과	1/2 개		
저 녁	밥	잡 곡 밥	1/3 공기		
	국/찌개	조개 된장국	1 대접		
	반찬	삼 겹 살 상 추 쌈	1 인분 10 장		
	김치	열 무 김 치	1 젓가락		
	간식	방울 토마토	10 개		

야식		맥주 (카스)	500ml		
	2 일째 (날짜:_____월_____일_____요일)			3 일째 (날짜:_____월_____일_____요일)	
		음식 이름(재료 이름)	먹은 양	음식 이름(재료 이름)	먹은 양
아침	밥				
	국/찌개				
	반찬				
	김치				
	간식				
점심	밥				
	국/찌개				
	반찬				
	김치				
	간식				
저녁	밥				
	국/찌개				
	반찬				
	김치				
	간식				
야식					

X. 국 문 초 록

골다공증은 전 세계적으로 문제가 되고 있는 질환 중 하나이며 완치가 불가능하고 골밀도가 저하되었을 때에 골절과 같은 증상을 통해 발견되기 때문에 예방에 초점을 맞추어야 한다. 골밀도 형성 및 증가는 탄생 후부터 꾸준히 지속되다가 20-30세 쯤 최대 골질량 (maximal peak bone mass)을 도달하였을 때부터 점차적으로 감소하게 된다. 따라서 20대 초,중반 시기까지 골밀도를 최대한 높이는 것이 골다공증 예방의 최상의 방법이라고 할 수 있다. 골밀도 형성에 영향을 미칠 가능성을 갖고 있는 것으로 알려져 있는 요인으로는 생활습관, 식이섭취 그리고 신체 조성이 있다. 이에 본 연구는 현재 한국 여대생의 골밀도, 생활습관, 식이섭취 및 신체 조성을 서술적으로 평가하고 이러한 요인들과 골밀도와의 관계를 조사하고자 하였다.

서울시 소재 일개 간호대학에 재학 중인 여대생 전 학년 중 160명을 대상으로 골밀도, 생활습관, 식이섭취 및 체성분을 측정하여 평가하였다. 자료 수집은 2013년 6월 10일에서 10월 25일까지 시행되었다. 골밀도에 관한 자료를 위해 종골 초음파 골밀도 측정기를 사용하였고, 대상자 특성, 과거와 현재의 생활습관과 식이섭취에 관한 자료를 위해 일대일 면담, 설문조사, 식이기록법과 24시간 회상기법을 이용하였고, 신체 조성에 관한 자료를 위해 InBody 720 체성분 분석 기계를 사용하여 측정하였다. 수집된 자료는 Windows SPSS 20.0 program을 이용하여 기술통계, t-test, chi-square test, one-way ANOVA로 분석하였다,

연구 결과는 다음과 같다.

여대생의 평균 골밀도는 (t-score) 0.37 ($\pm$1.26)이였고, 이 중 정상

군에 속하는 학생이 128명 (80%)이였고, 비정상군에 속하는 학생이 32명 (20%)이였다.

현재 규칙적인 운동을 하는 학생이 59명으로 총 대상자 수의 36.9%였고, 평균적으로 주 1.25 (±1.58)회 운동을 하며, 주 11.6 (±9.17)시간을 야외 활동에 투자하고 있었다. 과거와 현재 주 운동 시간을 조사하여 고 빈도 군 (>5h/wk)과 저 빈도 군 (≤5h/wk)으로 나눈 결과, 고 빈도 군에 속하는 학생이 초등학교 때에는 71명 (44.4%), 중학교 때에는 43명 (26.9%), 고등학교 때에는 22명 (13.8%), 그리고 현재에는 24명 (15%)으로 점차적으로 감소함을 알 수 있었다. 현재 카페인 섭취를 하는 학생은 144명으로 전체 대상자의 90%를 차지하였다. 이 학생들은 평균적으로 하루 1.69 (±0.95)회 카페인 섭취를 하였다. 조식섭취의 경우, 고 빈도 군 (조식 섭취)과 저 빈도 군 (조식 결식)으로 나누었다. 고 빈도 군에 속하는 학생이 초등학교 때에는 151명 (94.4%), 중학교 때에는 146명 (91.3%), 고등학교 때에는 148명 (92.5%), 그리고 현재에는 109명 (68.1%)명으로 조식 섭취률이 점차적으로 감소함을 알 수 있었다. 우유 섭취와 그 외 유제품 섭취 또한, 고 빈도 군 (매일 섭취)이 점차적으로 감소하였다. 고 빈도 우유 섭취의 경우, 초등학교 때에는 129명 (80.6%), 중학교 때에는 88명 (55%), 고등학교 때에는 62명 (38.8%) 그리고 현재에는 38명 (23.8%)이였다.

주중 2일과 주말 1일을 포함한 3일 식이기록법, 24시간 회상기법과 Can-Pro 4.0을 통하여 분석하여 각 영양소 별 권장량 섭취를 충족시킨 군, 결핍 군과 과잉 섭취 군으로 나누었다. 학생들 중 137명이 (85.6%) 나트륨을 과잉섭취 하고 있었고, 86명이 (53.8%) 콜레스테롤을 과잉섭취

하고 있었다. 하지만 109명이 (68.1%) 식이섬유 권장량 섭취를 충족시켰으며 81명이 (50.6%) 비타민 C 권장량 섭취를 충족시켰다. 104명 (65%)의 학생이 비타민 D 결핍을 보였으며, 84명 (52.5%)이 칼슘 결핍을 보였다.

신체 조성의 경우, 학생들의 평균 BMI는 21.3kg/m^2 (±1.97)이였고, 115명 (71.8%)이 정상군, 11명이 (6.9) 저체중 군, 34명이 (21.3%)가 과체중 군에 속했다. 체지방율의 경우, 평균 30.1%(±4.18)이였고, 112명 (70%)이 정상 군, 4명 (2.5%)이 저 체지방 군, 44명 (27.5%)이 고 체지방 군으로 나뉘었다. 복부지방률은 평균 0.81 (±0.03)으로 135명 (84.4%)이 정상 군 그리고 25명 (15.6%)이 복부 비만 군에 속했다.

대상자들을 골밀도 정상 군과 비정상 군으로 나누었을 때 유의한 차이 혹은 경향을 보인 변수들은 다음과 같다. 생활습관 중에서는 주 당 운동 횟수와 (p=.05) 하루 카페인 섭취 횟수 (p=.07)였다. 또한, 초등학교 때의 주 당 운동 시간 (p=.07), 고등학교 때 (p=.05)와 현재의 (p=.02) 우유 섭취 그리고 현재 조식 섭취 여부 (p=.07)에서 t−score의 차이가 있었다. 식이 섭취의 경우, 비타민 B5 (p=.07)와 copper (p=.03)만이 통계적으로 유의한 차이를 나타냈다. 신체 조성에서는 BMI (p=.06)와 키 (p=.03)에서 유의한 차이를 나타냈다.

본 연구 결과 한국 여대생들 중 간호대에 재학 중인 여대생의 경우, 운동 횟수와 카페인 섭취가 골밀도에 부정적인 영향을 미침에도 불구하고 규칙적인 운동의 부족이 있었고, 하루 평균 2잔정도의 지속적인 카페인 섭취를 하고 있음을 확인할 수 있었다. 고등학교 시절을 포함한 과거부터 현재까지의 우유 섭취가 골밀도에 긍정적인 영향을 미치지만, 우유섭취 빈도가

과거부터 현재까지 점차적으로 줄어드는 양식을 보였다. 현재 조식 섭취 여부 또한 골밀도에 좋은 영향을 미치는 요인으로 확인 되었으나, 과거에 비해 현재 조식 섭취율이 감소했음을 나타냈다. 식이 섭취의 경우, 과반수의 대상자가 전반적인 건강에 악영향을 미치는 나트륨과 콜레스테롤을 과잉 섭취하고 있었다. 골밀도 증가에 영향을 미친다고 알려져 있는 비타민 D와 칼슘섭취 결핍인 학생 또한 과반수였다.

따라서 한국 여대생의 골밀도를 포함한 전반적인 건강상태를 증진시키기 위해서는 골밀도를 강화시키고 전반적인 신체 조성에 긍정적인 영향을 미치는 꾸준하고 규칙적인 운동을 강화시키고, 카페인 섭취량을 감소시키고, 우유 섭취, 조식 섭취, vitamin D와 칼슘 섭취를 늘리고 콜레스테롤과 나트륨 섭취를 낮추는 포괄적인 중재 또는 프로그램을 강구해야 할 것으로 생각된다.

주요어: 여대생, 골밀도, 생활습관, 식이섭취, 신체 조성

학번: 2012-20426